This is a digital copy of a book that was preserved for generations on library shelves before it was carefully scanned by Google as part of a project to make the world's books discoverable online.

It has survived long enough for the copyright to expire and the book to enter the public domain. A public domain book is one that was never subject to copyright or whose legal copyright term has expired. Whether a book is in the public domain may vary country to country. Public domain books are our gateways to the past, representing a wealth of history, culture and knowledge that's often difficult to discover.

Marks, notations and other marginalia present in the original volume will appear in this file - a reminder of this book's long journey from the publisher to a library and finally to you.

Usage guidelines

Google is proud to partner with libraries to digitize public domain materials and make them widely accessible. Public domain books belong to the public and we are merely their custodians. Nevertheless, this work is expensive, so in order to keep providing this resource, we have taken steps to prevent abuse by commercial parties, including placing technical restrictions on automated querying.

We also ask that you:

+ *Make non-commercial use of the files* We designed Google Book Search for use by individuals, and we request that you use these files for personal, non-commercial purposes.

+ *Refrain from automated querying* Do not send automated queries of any sort to Google's system: If you are conducting research on machine translation, optical character recognition or other areas where access to a large amount of text is helpful, please contact us. We encourage the use of public domain materials for these purposes and may be able to help.

+ *Maintain attribution* The Google "watermark" you see on each file is essential for informing people about this project and helping them find additional materials through Google Book Search. Please do not remove it.

+ *Keep it legal* Whatever your use, remember that you are responsible for ensuring that what you are doing is legal. Do not assume that just because we believe a book is in the public domain for users in the United States, that the work is also in the public domain for users in other countries. Whether a book is still in copyright varies from country to country, and we can't offer guidance on whether any specific use of any specific book is allowed. Please do not assume that a book's appearance in Google Book Search means it can be used in any manner anywhere in the world. Copyright infringement liability can be quite severe.

About Google Book Search

Google's mission is to organize the world's information and to make it universally accessible and useful. Google Book Search helps readers discover the world's books while helping authors and publishers reach new audiences. You can search through the full text of this book on the web at `http://books.google.com/`

THE SUN

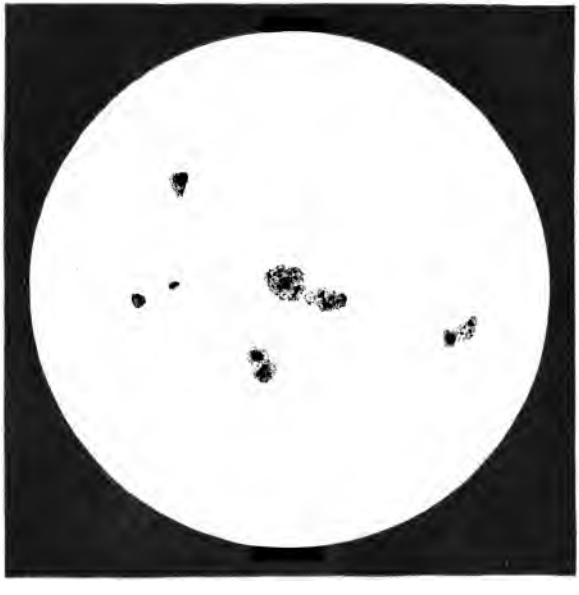
AND

HIS PHENOMENA

REV. T. W. WEBB.

THE SUN

LONDON: PRINTED BY
SPOTTISWOODE AND CO., NEW-STREET SQUARE
AND PARLIAMENT STREET



THE SUN

MARCH 2, 1884

THE SUN

A FAMILIAR DESCRIPTION OF HIS PHÆNOMENA

BY THE REV.

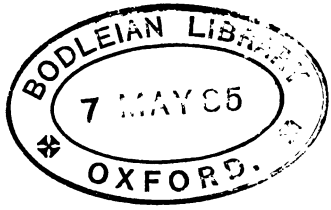
THOMAS WILLIAM WEBB, M.A. F.R.A.S.

VICAR OF HARDWICK, HEREFORDSHIRE; AND
PREBENDARY OF HEREFORD CATHEDRAL

LONDON
LONGMANS, GREEN, AND CO.
1885

All rights reserved

18423. f. 1.


BODLEIAN LIBRARY
7 MAY 05
OXFORD

PREFACE.

NOTWITHSTANDING the multiplication in late years of popular treatises on Astronomy, it has been thought that there might still be room for a description of the Sun, which, confining itself to a brief but careful enumeration of its phenomena, may be found serviceable in elementary instruction.

THE SUN.

ASTRONOMY—the knowledge of the heavens—is generally admitted to be the first of all the sciences. Every science, every inquiry into the works of God, is interesting, for each is full of wonders of its own, and wonders that grow upon us as we search into them. But, for several reasons, Astronomy stands at the head of them all. One reason is the exceeding glory and splendour of the objects it brings before us. Another is, because it acquaints us with distances, magnitudes, and velocities astonishing beyond comparison. Another, because it opens out before

us scenes of the most orderly, harmonious, and exquisitely proportioned movement. Of every science it may be said that it is full of the traces of the Creator, but of Astronomy, that it is the chief declaration of His glory, the especial showing of His handiwork. The very little that David could know sufficed to teach him this; that teaching is a thousand times expanded and confirmed by the advance that has been permitted to modern inquiry.

This noble science has several distinct branches. There is Theoretical astronomy, such as that of Kepler, Newton, and Laplace; the mathematician's view of it, dealing with laws and proportions and calculations far too deep and abstruse for any but specially trained students. There is what we may call by a convenient though rather uncouth name, Observational astronomy, which consists in the measurement by suitable instruments of the apparent

positions and magnitudes of the heavenly bodies, on which all calculations must be founded; and there is Descriptive astronomy, which tells us what has been discovered as to the appearance and movement of these wonderful objects; and this branch alone admits of being treated, and that only in its simpler parts, in an easy and familiar way. Shall we make an attempt to understand some little about it? It will be our own fault if we do not find it most interesting as well as useful. We must recollect, however, that even in its simplest beginnings the subject is a large one; and we, therefore, propose in our present undertaking to take up merely one portion of it, and that portion shall be

THE SUN.

And good reason we have for our choice. Of all the objects that the sight of man can reach, the Sun is beyond comparison the most

glorious and impressive. But more than this: What should we do without him? Without his light and warmth, and probably many other less apparent, but most essential, benefits, what would be the condition of our globe? Death from starvation. Were he extinguished in the sky —were his Creator thus to 'darken the earth in the clear day,' our globe would speedily become a bare and silent waste. In ways past description and even conception, the Sun is the source of all our life and all our happiness—whence, indeed, he is referred to in Holy Scripture as the type of the unchangeable Fount of spiritual and eternal life and peace and joy. And besides this, we wholly depend upon the Sun as the centre of the earth's movement, as the controlling power that guides our path in space, and keeps us unswerving in our appointed way.

Such in few and most inadequate words is the Sun to us. But what is the Sun in him-

self? What is his nature? What is he made of? What causes that mighty and ceaseless streaming forth of light and heat and power? And what is his real size? And how far is he away? Can we get answers to these most natural and interesting questions? To some of them we can. But even those are not every-day inquiries, and part of them are difficult enough, so we had better begin with what may seem the easiest. Let us try to get some idea how large that glorious object is. What should we suppose? We might say almost anything, and our answer would be worth just nothing. Few things are more unmeaning or senseless than the way in which many people speak of sizes and distances in the sky. They talk of feet or yards as if they were actual measures up there. But a foot, or a yard, means nothing unless we can tell its distance from the eye. A sixpence held near the eye will cover the Sun

many times over, but it would be a curious inference that therefore the Sun must be smaller than a sixpence. At a mile distant we could not see the sixpence, while the Sun looks always of the same size. For apparent size means nothing till distance is taken into the account, and then, but not before, the real size may be made out. So the first thing we have to do, before we can know how large the Sun is, is to find how far he is away. And how is that to be done? I must tell you first that it is possible, and then you may be glad to learn how.

Let us consider how we find the distance of any object. We cannot, in very many cases, use measuring rules or tapes. We judge sufficiently of the distance from the different directions in which we see it from two different points of view, or *stations*, as it will be less troublesome to call them. If an object appears in the same direction from whichever station we

view it, we can form no idea of its distance; but if its position seems to be shifted by our moving from one station to another, we can judge from the amount of its shifting how far off it really is. For near objects, our two eyes furnish us with two stations, which we are continually employing without, in general, being aware of it; if we had but one eye, we should be obliged to move it to a fresh position in order to judge of the distance of any near object, as we may easily satisfy ourselves by trying to thread a needle while one eye is kept shut.[1] But the distance between the two stations must not be too small in proportion to the distance of the object, or this method will fail us. Look at a distant prospect through a closed window only two or three yards from

[1] Of course the judgment of the single eye is assisted by the difference in the apparent size of the object at varying distances; but the main principle is that given in the text—the employment of different points of view.

you, putting your hand first over one, then over the other, eye. You will, of course, find the window-bars shifted, according to which eye you use, across the hills or trees behind them: and this is because the distance between your eyes, though less than three inches, is not very small in proportion to your distance from the window. Now try this much further from the window; you will find much less shifting of the bars across the background, because the distance of the window is getting rather long for the distance between your two eye-stations; and at greater distances still, it would make no difference which eye you used; and to shift the apparent place of the window, or any suitable intermediate object, with respect to the far distant hills, would require you to increase your station-distance by removing sideways so as to get a fresh point of view. You will easily see that there are two condi-

tions of success in this process. The distance between the two stations, which is called the *base-line*, or simply the *base*, must be accurately known, and it must not be too small as compared with the distance of the object, or the result will be uncertain in proportion.

This *apparent* shifting of the place of any object by a *real* change of place in the observer is called in astronomy *parallax*; and we ought to master the nature of it thoroughly, for without it we shall not have a single reliable idea of the distances or sizes of any of the heavenly bodies. And we have need of it at once to answer our question, How large is the Sun? For this will depend upon his distance, and that will follow from his parallax; and that again would be found, according to our rule, by noticing how much his place in the sky, as ascertained by suitable instruments, is changed by changing the station of the observer. But here we at

once encounter the first of our difficulties. Our best instruments show no perceptible difference in the Sun's position in the sky, as viewed from two stations at any conveniently measurable distance—suppose of a few miles. Such a base-line, then, turns out too short; but how are we to get one long enough, when the labour of actual measurement becomes intolerable, and the task of keeping a straight line all the way, from station to station, would be hopeless? Here a branch of mathematics called *trigonometry*, or the measurement of triangles, will give us effectual help, and in a way that fortunately, notwithstanding that hard name, is of easy explanation; especially by attending to this diagram:—

Two stations A and B are taken at a convenient distance apart, which is very accurately measured; then an object, such as a church spire or a pole placed on an eminence, is to be

chosen, at a greater distance, and in a suitable direction: this we shall call C. C is then to be viewed by surveying instruments from each of the ends of the base A and B, and the angle which its direction, A C or B C, makes with A B is to be carefully measured; so that out of the

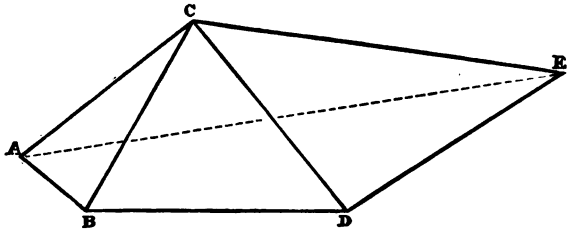


FIG. 1.

six parts of the triangle—namely, three sides and three angles—we have ascertained the value of one side and two angles; and these being known, the rules of trigonometry give us the length of the other two sides, and thus we find the length of B C and can make a fresh

base of it, and, so again, by the same process, find the length of C D, and from that the length of D E, and so on for any required distance, the final distance, such as from A to E, being obtained by similar processes. We may thus get a very much longer base, of hundreds of miles if we please, but only to be disappointed; our instruments will still break down, and the Sun's distance turn out as unapproachable as ever. But a curious result will come out. It will soon be evident that by the extension of this process of measurement we might ascertain another fact of especial interest—the size of our own globe. Not, indeed, by a direct attack, as so much of it is covered with water; but in an equally sure, though more circuitous, way, which we shall find no great difficulty in understanding.

Every circle, whatever its size may be, naturally divides into halves and quarters. But

we are continually wanting smaller divisions; and it has been agreed upon by mathematicians to conceive the whole compass, or *circumference*, to be divided into 360 parts: a most convenient number, from its ready division into so many equal parts without fractions, as we should find upon trial. These 360 parts are called *degrees*, and marked by a little circle thus, 360°, and into these every circle, large or small, is supposed to be divided. Now the Earth being a globe, we shall easily see that if we could travel all round one side of it from N. to S., and by the opposite side from S. to N. again, we should have traversed a circle of its surface, that is, 360°. But again, the Earth being a globe, the sky must lie round it on every side, so that, little as we are apt to think of it, the starry heavens are at noonday under our feet; and in travelling all round the Earth we must pass under every part of the sky, and

as each is divided into 360°[1], if we find we have passed under 1° of sky, we must at the same time have passed over 1° of Earth. Now we have instruments that will show very exactly the beginning and ending of each degree in the sky, and show the corresponding points on the surface of the Earth. And, therefore, when we have measured, by the process we have just explained, the distance between the two ends of a degree on the Earth, we have only to multiply it by 360 to find the whole circumference, and hence we know again that the *diameter*, or measure right through the centre of the Earth, from pole to pole is very nearly 7,900 miles. In the opposite direction, at right angles, it measures a little more; but

[1] The degrees of the Earth are real distances; those of the sky are merely divisions of space. But this does not affect the question. If the real divisions of the Earth can be pointed out by the imaginary ones of the sky, it is all we require; and this can be done with certainty.

that is beside our present question. And possibly some reader may say, so is all this digression about the measure of the Earth. But if so, it is not without its value. It not only helps us to a very serviceable knowledge of some most important processes in elementary astronomy, but it gives us our first distinct idea—and a startling one it is—of the immensity of the Sun's distance. For if we take two stations on the Earth, even 5,000 or 6,000 miles apart,[1] the difference of the Sun's place in the sky as seen from each of them, though perceptible with very fine instruments, will be

[1] We do not give the *whole* diameter of the Earth as our base, because the Sun in that case would be too low at both stations in the vapours of the horizon to be accurately observed. But the numbers in the text are amply sufficient, measured of course by an imaginary line through the thickness of the Earth, and not along its surface. Two of the most distant observatories—Hammerfest, in Norway, and the Cape of Good Hope—are nearly N. and S. of each other, and 6,300 miles apart in a straight line.

so small and so uncertain, as to give no dependable result. Our whole globe, we find, is not large enough to form a base for that measure.

But as in our first experiment we moved the head, if the distance was too short between our eyes, cannot we do something of the same kind now? The Earth is constantly changing its place as it moves in its path, or *orbit*, round the Sun; will not its fresh position a month hence compared with its present one give us a sufficient base-line? Certainly. But we have to find its length, and that we can only do from the Sun's distance, instead of finding the Sun's distance from that length, which involves us in an absurdity.

However, there is yet another way. The Sun is the centre of the orbits of a number of smaller globes called *planets*, of which the Earth is one; and there is such a wonderful proportion established in this planetary system by

Creative Wisdom between the times of their going round the Sun, which may be easily observed, and their distances from him, that any one distance being found out (or the distance of any one from the Earth, which comes to the same in the end) all the rest will follow.[1] It is like a plan of a building drawn correctly to measure; but of the size of which we can form no idea without a scale. The Sun's distance would, of course, give the scale; but, as we now see, it would be very difficult to find

[1] The distance of the Moon from the Earth is easily found, but will give us no aid, because, not being in a direct sense a member of the planetary system, but only a companion of the Earth, she is not included in the proportion mentioned in the text. This proportion, in mathematical language, is that the squares of the times of the respective revolutions of the planets round the Sun are in the same proportion as the cubes of their distances from him; easily remembered in a reverse order by the alphabetical sequence of the initial letters, C D, S T. It is called the Third Law of Kepler, after the eminent mathematician who discovered it.

from its length. Still, any one of the distances of the planets from the Sun or from each other would answer equally well, owing to the exact proportion among them all; so we must look out for as short a distance as we can, and see whether that is measurable; that is, whether any of those bodies ever comes near enough to us to show us a decided and well-marked parallax, from which we may find a scale for the whole.

Now we know from observations of her path in the sky that one of the planets, called Venus, sometimes comes nearer to us than any other of the group; and as her orbit round the Sun is inside our own, she must be nearest of all to us when she comes between him and ourselves. But as she has no light of her own, though such a brilliant object when she is a morning or evening star, but only shines by reflecting the Sun's light, she would in that

position turn her dark side to us and be invisible, unless she was exactly in a line between us and the Sun, in which case we should see her as a minute black speck passing slowly across his face. This does sometimes happen, and is called a *Transit of Venus.* Now the grand proportion that we have been speaking of teaches us that, if we call the Sun's distance from us 100, the distance of Venus from us, when in that position, will be only about 28; and, consequently, though the Sun's parallax in the sky is too small for our instruments, yet that of Venus on the Sun as a background will be nearly four times as great, large enough for measurement. Most fortunately this is the case. We shall get our scale at last, and be able to ascertain, not only the Sun's distance, but the whole dimensions of our system. And this is, indeed, so interesting and valuable a result that we need not regret the pains we

have taken in getting to understand the principle of the proceeding.

We must not, however, expect too much. Though possible, it is not an easy matter. The parallax of Venus in crossing the Sun's disc, which, as you now know, means its apparent displacement N. or S., E. or W., as seen at the same moment from different stations on the Earth, can be plainly seen with the telescope; but still the quantities to be measured are very minute and subject to many causes of error, so that we want a great many transits to get a dependable *mean* or average value; but instead of many we are obliged to be contented with very few, for though Venus goes round the Sun in such a way as to come between him and us once in every 584 days—little more than a year and a half—an actual passage across his face is a very uncommon thing. Now, what is the reason of this?

It is because the orbit of Venus does not lie in the same *plane* or level as ours; they could not both be drawn truly on the same piece of cardboard, but are tilted a little so as to slope across each other, one half below, the other above, the planes intersecting only in two opposite points or *nodes*, as in this diagram, where, however, no proportion is observed, only the principle shown:—

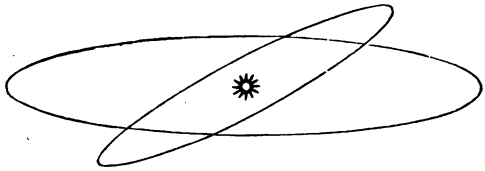


FIG. 2.

The position, too, of these nodes is constantly changing, which increases the difficulty; so that, as both planets must be nearly in the same plane in order that the outer one may see the inner one somewhere on the Sun's face, the chances are that, wherever we may be

in our orbit, when Venus comes between us and the Sun, she will be likely to pass too high or too low to be seen to cross his face; and such we find is the case. We may have actually to wait for a transit for 122 years; after that time another follows in 8 years; then the next will be 105 years; then 8 and 122 again, and so on; and, consequently, as astronomical instruments of sufficient perfection are comparatively modern, only the transits of 1761, 1769, 1874, and 1882 have been observed well enough to give us an idea of the Sun's distance. No wonder that, the opportunity being so rare, and the result so important, much should be thought of a Transit of Venus, or that the Governments of Europe should at these times have sent out expeditions at considerable expense[1] to far distant quarters of

[1] We may well bear in mind, however, the remarkable reply of our King George III. to Lalande, when the latter

the world, to get as many and as long base-lines as possible, and to avoid disappointments from weather; and we have at last got out a result, which is believed to be fairly accurate, of something less than 93 millions of miles for the distance of the Sun.

This value has been confirmed by a process similar in principle, but worked the opposite way. As Venus passes at regular intervals between the Sun and the Earth, so does the Earth pass between the Sun and the next outside planet, Mars. We pass him at a greater distance than Venus passes us, and therefore his position as observed from a base-line on the Earth is less favourable for parallax, but still he is near enough for our purpose; his change of position among the surrounding stars, as

complimented him on his liberality in regard to Sir W. Herschel's great telescope—'Ne vaut-il pas mieux employer son argent à cela qu'à faire tuer des hommes?'

seen at the same time from different stations on the Earth, can be measured, and the distance of the Sun thus obtained indirectly from the distance of Mars comes nearly to the same as that found by means of Venus. The following diagrams will illustrate the principle of the two processes; they are, of course, in utter defiance of proportion, as is continually happening in such cases, but too often without

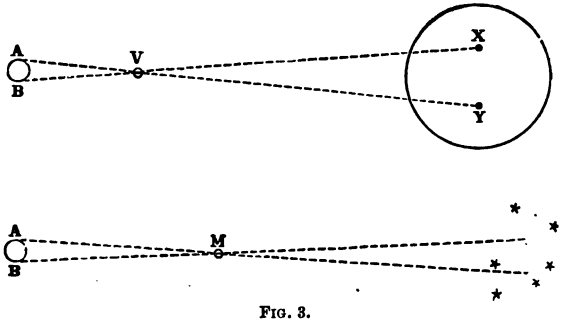


FIG. 3.

due notice being given. In No. 1, A and B are two distant stations on the Earth, from which

V, Venus in transit, is seen at the same time at the points X and Y respectively on the Sun's disc, at a distance from each other not too small to be measured. Then it will be seen, from what we have said about trigonometry, that, the distance A B being known, and the angles at A and B being found from the distance X Y, the distance A V (or B V) is known, and hence all the other distances in the system. In No. 2, M is Mars, seen in like manner from A and B in a different position on a background of stars; a similar process gives the distance A M (or B M).

The results thus obtained are confirmed by other methods which we cannot explain here; and thus, on the whole, the distance which we have been so long seeking comes out, as we have said, rather less than 93 millions of miles —93,000,000! What an enormous array of figures! And what do they express? Can we

take that in? Can we form a sufficient conception of even 93 thousand miles—that is, of only a thousandth part of the Sun's distance? It is simply impossible. But we may try to get some kind of idea in another way. Walking 4 miles an hour, and 10 hours every day, a man would travel as far as the Sun in 6,300 years. By an express train at 60 miles an hour, we should die long before our journey of 175 years was ended. A cannon-ball would take about 9 years to do it. Sound travels about 1,100 feet in a second,[1] so that unless the flash of lightning is close at hand, we do not hear the thunder till a little afterwards; and if it lightened on the Sun, and there were air between us to carry the sound, the thunder-peal would not reach us for fourteen years!

[1] By a *second*, in astronomy, we always mean the sixtieth part of a minute, the beat of a tall old-fashioned hall clock, not the ticking of a small timepiece in a sitting-room.

But all such illustrations come utterly short; and we must not forget our next question, proposed a long time ago—How large is the Sun?—for we are able to answer it now. Astronomers can measure the breadth of his face, or *disc* as they call it, and find it about 32 minutes (marked 32′), and as there are 60 minutes in a degree, that means rather more than half a degree. Now, you will recollect that all round the sky—that is, all along the horizon—there will be 360°, and of course the height to the over-head point, or *zenith*, will be 90°, so that at sunrise or sunset it would take about 169 suns, one close above another, to reach the zenith, or 675, side by side, to compass the horizon.

This measure, you may be surprised to hear, is not always exactly the same. I do not mean that the Sun looks larger at rising or setting; for that is a mere deception, though a curious

one. It probably arises from our false idea of the apparent form of the sky, which really has no form, being boundless, but looks nearer overhead, because the clouds, which seem to mark out its shape, are really so. These, of course, appear much smaller in the horizon, being much further off; and we suppose that the Sun, and indeed the Moon also, would follow the same rule, and appear smaller there; but as they do not, which can be proved by actual measurement, we get a mistaken impression that they look very large in that position, because we think that they ought to appear much smaller at a supposed greater distance. But we are not speaking of this deception, but of the fact that even at noon-day there is a real difference in the Sun's apparent diameter in summer and winter, not perceptible by the naked eye, but very visible in telescopes. This must have a meaning, because it is always the

same at the same time of year; and from what we have learned we shall at once perceive that its meaning must be a corresponding change of distance. And what follows? That the Earth's orbit cannot be a circle, because every part of a circle is at the same distance from its centre; and the proportional change of size, when watched from month to month, proves it to be a regular *ellipse*, or oval, of which the Sun is not in the middle, but nearer one of the ends. Such a figure we could easily draw, if we stuck two pins in a board a little distance apart, and let a loop of string lie loose round them both; inside this loop we put the point of a pencil, stretch the string to its full extent, and carry the pencil steadily round the two pins. The curve thus marked out will be an ellipse, the form of which, or, as mathematicians would say, the amount of its ellipticity, depends both on the distance of the pins and the length of the loop,

the general rule being, that the closer the pins are together in proportion to the length of the

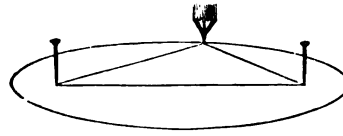


FIG. 4.

string, the more the ellipse resembles a circle. This experiment is well worth trying, because ellipses are continually occurring in astronomy. The points where the pins stand are called the *foci* of the ellipse (singular, *focus*), and the Sun is in one of the foci of the Earth's orbit, which is distinctly elliptical; nothing like what is shown in our diagram, but still so much so that he is about three millions of miles nearer to us at the one end of it than the other. Strange as we may think it, he is nearer to us by this amount, and therefore apparently larger in proportion, in mid-winter than at mid-

summer; this, however, only holds for the N. half of the globe, and the difference is more than counterbalanced to us by the shortness of the days and his lowness in our sky.

Now, then, for his real size at last. At 93 millions of miles away, these 32′ mean about 866,400 miles. Such is the *diameter*, or through measure, of that sphere. What a stupendous ball of fire! Our Earth is in itself a magnificent globe; and at a few thousand miles' distance it would be a very imposing object, filling most of the sky, and rolling before the spectator with swift and steady velocity. Yet it shrinks into absolute insignificance in the presence of the Sun. The diagram on next page may give some notion of the proportion of the diameters; but a flat circle is perfectly inadequate to give the imposing effect of a globe. 109 of our Earths touching one another would hardly cross the Sun from side to side. An

ordinary express train would require more than seven years to compass it round. Our globe, if

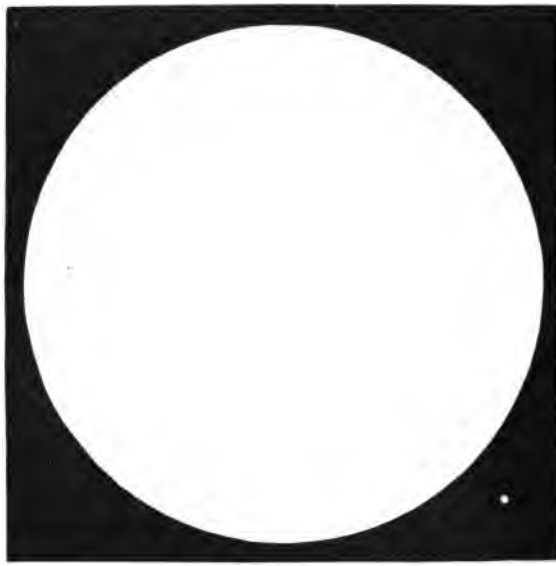


FIG. 5.

it were like a balloon, would have to be blown up to 1,305,000 times its size to equal the bulk of the Sun. If we represent the Earth by a

little three-inch ball, we must match the Sun by a balloon of more than nine yards in

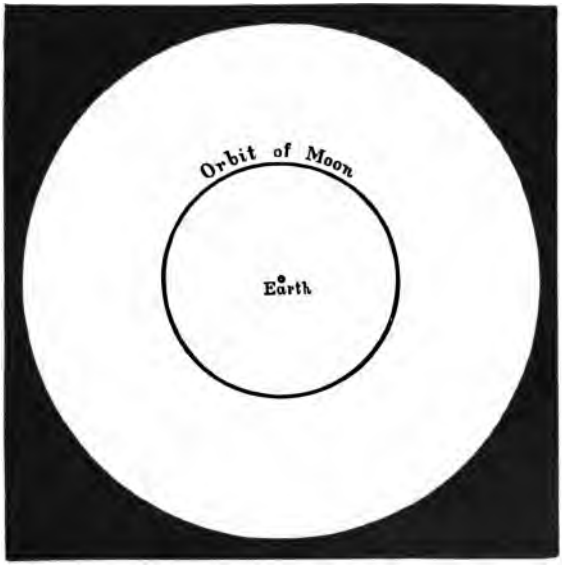


FIG. 6.

diameter, and then place it nearly 1,000 yards away. Or, to take another mode of illustration: The Moon revolves round the Earth at a

distance of 240,000 miles; the Sun would include all that orbit, and nearly half as much again, as in this diagram.

This astonishing globe is not, however, so dense as the Earth—that is, it does not contain so much more matter in proportion to its bulk. Its density is little more than one-quarter that of the Earth; still, from its enormous size, it would counterbalance 330,000 Earths; and its attractive power is such that projectiles, such as shot and shell, would have a very short range, and an ordinary man of 150 lbs. would weigh nearly two tons there, and be unable to lift his feet from the ground, if there were ground to stand upon; unless his muscular strength were increased in proportion, his own weight would crush him to flatness.

We have reason to believe that every globe in the sky, of which there are very many, turns upon a fixed line passing through its centre,

which we call an *axis*, and the two ends of that axis, where it reaches the surface of the globe, *poles*; but of course we cannot perceive this turning, or *rotation*, in any instance unless there are marks on the globe to show it. Such marks seem so unlikely on the glorious body of the Sun, that some of the ancient philosophers would not believe them possible. But there they are, often to be seen with a telescope, sometimes with the naked eye through a fog or coloured glass—the *Spots in the Sun*—dark specks moving across his face from W. to E. at a rate that keeps them in sight for days together. But are we sure that they are in the Sun? Why should they not be something floating between him and our eye, and not connected with him at all? For two very satisfactory reasons. Their rate of motion is—what it should be if on the surface of a globe—much quicker across the centre than near the edges of the disc, and their

change of form from slenderness when first seen near the edge, or *limb*, as it is called, to roundness in the middle, and slenderness again as they approach the opposite limb, belongs only to objects on a spherical surface. And thus the rotation is proved.

A diagram may show this clearly, by exhibiting at once the different rate of visible progress and the changes of apparent form in

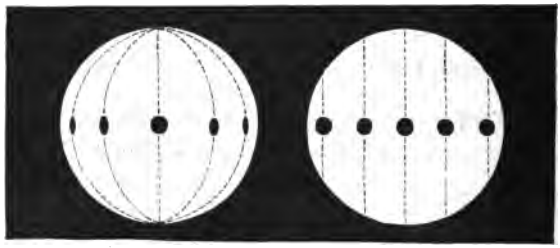


FIG. 7.

an object attached to the surface of a rotating globe, as compared with one moving independently in front of it.

But how long does this rotation take? The spots that show it show also a strange peculiarity about it, that it is quickest at the *equator*, or central line round the largest part of the globe, half way between the two poles, and gradually slower as we go further either way, either N. or S., as we should say on the Earth. It would appear from this that the surface cannot be of a solid nature; and from this difference of velocity, which has not been satisfactorily explained, as well as from the changeable form of the spots, it is impossible to give any accurate value for the rotation of the Sun. But we cannot be far wrong in assigning about twenty-five days as the rotation of the equator, and twenty-seven and a half days for the regions half way to either pole; beyond which limit all is doubtful, as spots are scarcely ever to be seen there. All the spots, however, take about two days longer to come round again

to the same apparent position on the disc, as the Earth has not been standing still in the meanwhile, but has been advancing to a fresh position in its yearly orbit round the Sun.

It is usually the case with rotating globes that they are a little flattened in the direction of the axis, and our Earth is an instance; but nothing of the kind has been detected in the Sun, which appears to be a perfect sphere.

A rotation in twenty-five days seems slow to us who are turning in twenty-four hours. But owing to the enormous size of that globe, that looks large to us even at such a wonderful distance, it is really so far from slow, that at the equator, where we on Earth are travelling rather more than 1,000 miles an hour, the Sun is flying nearly four and a half times as fast, one and a quarter mile every second. Greater velocities are to be found among the heavenly globes; but could we look upon this motion of

so huge a mass from some neighbouring position, the impression would surely be unendurable by mortal brain.

If we trace the path of these spots across the disc, we shall find it straight only twice a year, in June and December, curving a little up-

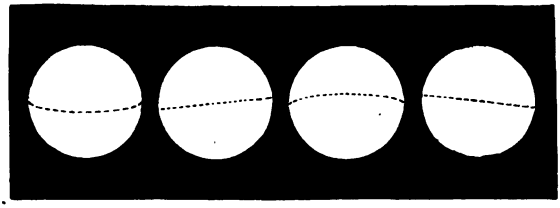


FIG. 8.

wards in March and downwards in September; and when straight it is not level, if examined at noonday, but slopes a little to the right in June, and left in December. This proves, as a diagram will show, where the dotted line marks the Sun's equator, that his axis is not upright, with respect to our orbit round it,

but tilted sideways, though not to any great extent.

But now we come to ask—What are these spots? what are they like? how large? and of what nature? We had better first attempt to study the surface on which they are found. The Sun sets before us a disc of such blazing and insufferable splendour, far surpassing the brightness of all light upon earth, the electric light itself looking black in front of it, that much care is necessary to protect the eye from injury. This is done, in such telescopes as are likely to fall in our way, by a *solar cap*—that is, a piece of deeply stained glass, screwed on the end next the eye, so as to intercept a portion of the light and heat; with large instruments still greater precautions are necessary. But this being done, no sooner do we get a distinct view of that brilliant disc than we are struck by the want of uniformity in its texture. The

general bright surface—or *photosphere*, as it is called—is found, with the finest instruments and in the steadiest air, to contain a multitude of excessively minute points of intensest whiteness, clustered into knots or tufts called *granules*, or from their general form *rice-grains*,[1] which float as it were in, or on, a greyer base, with no regular arrangement; they are, however, sometimes so gathered into larger masses as to give a coarsely mottled aspect to the whole disc. In some parts the granules are compressed into crooked or branching and complicated streaks called *faculæ*, brighter than the general surface, and frequently running to long distances, even as far as 40,000 miles, with a breadth of 1,000 to

[1] The aspect of these objects has been referred to the interlacing of a multitude of longer and more pointed forms, which have been compared to 'willow leaves'; but the statement in the text is that now generally adopted.

4,000 miles. They are usually much less visible in the centre of the disc than towards the limbs, where the general light of the photosphere is subdued, as it would seem from some kind of absorption, to about three-quarters of its strength, and so forms a less brilliant background, bringing out the faculæ, which appear to rise above the level of the absorption; in fact, their greater height has been evident, in some instances, from their showing as ridges on the outline of the limb.

And now we can understand better about the spots. These may be described as occasional interruptions in the photosphere, very seldom entirely absent, but having distinct alternations of *maxima* and *minima*, or frequency and rareness. Such changes come round pretty nearly every eleven years on an average, though with considerable irregularity, generally showing an increase during about

four and a half years, and a decrease during the remaining six and a half. The last maximum was somewhere about 1882. But the spots do not occur in every part of the disc. From some unknown cause they comparatively avoid the neighbourhood of the equator, and are generally found only in two broad belts or zones, N. and S. of it; beyond 45° on the Sun's globe —that is, half-way from the equator to either pole—they are very rarely seen. They are of very various sizes, from a minute point to an enormous area, occasionally far larger than our Earth. The largest measure since telescopes have been used gives about 30,000 miles across, besides a lighter border to be presently described, which has been known to increase the range to upwards of 143,500 miles [1]; far

[1] An uncertainty arises as to some of these statements from vagueness of description, which leaves it questionable whether the penumbra (to be mentioned afterwards) has been included or not in the measure.

beneath such a size they become visible, through cloud or mist or smoked glass, to the naked eye. And often they are massed in groups; one of which has been said to stretch away for some 290,000 miles.

But we must come a little closer to our question. What can we compare them to, these blots in the surrounding blaze? There is nothing misty about them; their outlines are sharp and seldom regular, often with angles and corners. The central and darkest portion is called the *umbra*. Though very dark from contrast it is not quite black, as Venus is in transit; and its deep grey is sometimes tinged with reddish brown. It is said, though one hardly knows how to conceive it, that if the brilliant surroundings were shut off by a screen, the umbra, dark as it is by contrast, would shine insufferably to the naked eye. The spots are believed to be cooler than the surrounding

surface. In the inside are often veils or streaks of feeble light, and occasionally a still darker space like a hole, called the *nucleus*. All around the umbra, if the spot is of considerable size, there usually lies a broad fringe of lighter grey, the *penumbra*, following the general shape of the umbra, but with a less angular outline; one such border frequently including several adjacent umbræ. The shading of these spaces proves that they are not a mere dilution or fading away of the umbra, for they are brighter nearest to it and darker towards their outer edge, which is usually well defined; and the comparison with a fringe is apt enough, as they are made up of a number of narrow bright threads packed together more or less regularly side by side, usually straight, sometimes curled at the ends, with occasionally others lying across them; and now and then a bright thread running across both umbra and penumbra, so as to

form a bridge of light; this happens especially when a large spot is breaking up in its decay. There is no rule as to the quick or slow breaking out or closing up of these spots, or the whole time of their duration; but none are absolutely permanent, though there have been strong suspicions that after disappearing they sometimes return in their former places; and their existence is never very long, ranging from a few days to as many months; in the latter case of course passing away from the disc and coming round again from behind it at the opposite limb; the longest duration recorded is eighteen months. Some of them do not vary much in appearance from one day to another; others surprise us by great and sudden changes in size and form; occasionally, as watched day after day, they are found to turn very slowly round their centres; and sometimes the penumbræ show a spiral arrangement, as though subject

to a whirling action. If you would like to look for these strange objects, as there is generally a chance of some being in sight, any little common telescope would show you the larger ones; but unless it is provided with a proper dark cap at the small end, you must guard your eye with a little bit of glass smoked to different depths over a candle, and protected from rubbing by another bit of glass, threads being passed and tied between and round the ends, so as to keep them from either touching and rubbing, or coming apart. But you will not be able to see much detail without a good telescope; and that is pretty sure, as we have said, to be provided with a proper solar cap of dark glass, that screws on when required. A general view of the spotted disc will be found on the frontispiece; an idea of the details may be obtained from this diagram, representing the great spot of 1865, October 7 and 16, highly magnified.

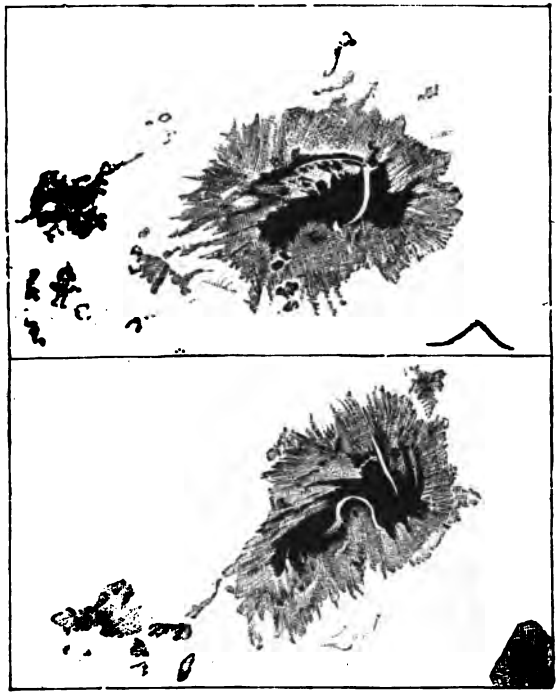


FIG. 9.

But what can these spots possibly be? Surely on so magnificent and important a body

they must mean something very remarkable. What, then, is their nature? A question that must go, I am sorry to say, without any very satisfactory answer, though great pains have been taken with the inquiry. To begin with: the spot must, of course, be either above, or below, or level with the surface of the photosphere; no one can tell which from its appearance when in the middle of the disc, but near the limb perspective ought to show which it is. If above, the umbra would project so as to hide the part of the penumbra, or even of the photosphere, beyond it; but this has never been observed. If all were level, the E. and W. sides of the penumbra would be respectively equal when near the limb; and indeed this would be the appearance if the penumbra were level with the surface, the umbra below it. If the umbra and penumbra were both below, or the penumbra sloped down to the umbra, the

fringe should appear contracted next the eye, and the umbra out of centre in the same direction. Now in more than 600 cases studied on purpose about three-quarters had this last appearance, and the others might be explained from the very frequent irregularities in the breadth of the penumbra; so that we may probably suppose that the spots are actual openings in the photosphere, through which we look down on something beneath, at a level ranging, it is believed, from 2,000 to 6,000 miles, or sometimes more. And this view is confirmed by the fact that on more than one occasion a large spot in leaving the disc has been seen as a shallow notch in the limb. A few observers still think, as some of the earliest did, that the spots consist of scum or dross on a fused globe, chilling the part beneath, and not rising to a higher level. But the former idea is far more prevalent. Such an opening

might be caused by a disturbance of equilibrium—either a powerful rush of hotter vapours from below or of cooler currents from above; and each view has its supporters. At any rate, the disturbance of the photosphere for some distance around is shown by an increased brightness of surface, where the granules are compressed into faculæ, or strung together so as to resemble straws in thatch; and such violent currents, or something of that nature, are found in the interior of the spots that changes take place often at the rate of 300 or 400 miles, or even 1,000 miles and more, in an hour.[1] It has been supposed that in the ordinary state of the photosphere the granules are the upper ends of threads of light hanging

[1] We may just refer to some recent observations of numerous faint grey misty patches of a very changeable and fugitive character. These, which have been called 'veiled spots,' will doubtless be the subject of further examination.

in a vertical direction, and that when a disturbance happens those threads are forced or drawn into such a sloping position that we get a slantways view of them in the penumbra, like a fringe. But supposing this to be so, what those brilliant threads are, who can tell? or what it is that we look upon in the darkness of that umbra and nucleus? May we ever hope to know? Probably not. Conjecture must satisfy us; and the most probable supposition is that the interior of that majestic globe is a mass of dark, intensely heated gas, condensed perhaps to the consistency of pitch, and not transparent, or the photosphere on the other side would be visible through the spots on this. To which we may add, if we please, an inference, drawn from theory, that the true globe of the Sun is very much smaller than the surface that we see.

Conjecture, again, must satisfy us as to the

nature of those brilliant outbursts which have on very rare occasions been observed on the Sun's surface, or more probably at some little distance above it. One of these is quite unquestionable, having been witnessed by two observers at a considerable distance from each other, and for about five minutes. It broke out suddenly among, or in front of, a great group of spots, whose aspect it did not at all derange, in the form of two small white specks, so intensely brilliant as even to dazzle the protected eye with a light far surpassing the photosphere or any imaginable terrestrial brightness, and moving gradually through about 35,000 miles before extinction. This amazing spectacle may possibly have been the ignition and dissipation of some huge metallic or earthy mass, attracted from a distant region; for we know that what we are apt to consider as the voids of space are teeming with a countless

multitude of projectiles, commonly known as 'shooting' or 'falling' stars, by far the greater part of which fly past us, or are scattered into our atmosphere, though a few occasionally reach the surface of our globe. It has even been supposed that, by the incessant showering in of these meteors upon the Sun, a supply is provided to replace that immense amount of light and heat which he is continually emitting in every direction, and of which scarcely the minutest fraction ever returns to him again. In fact, except on this supposition, or on that of a gradual contraction of the solar globe, only to be perceived in the course of ages, there seems no way of providing for the repair of this enormous expenditure. And there is abundant evidence to show that, whatever may have been the case in those times of which geologists speak, there has been no material change in

the climates of the Earth since the commencement of history.

And this brings in a very natural, but at present it may be feared not very hopeful, inquiry, what may be the temperature of that blazing disc? We have reason to suppose that it would not be the same in all regions or at all depths; but we may well believe that it must be enormous upon the whole, not only from the brilliancy of the light connected with it, but from its being the source of all, or nearly all, the warmth upon the Earth; and yet our globe, from its comparative minuteness, catches only the $\frac{1}{2,200,000,000}$ part of the whole diffusion of heat as well as light that is flying from the Sun throughout all space. Various modes of experimenting have of late years been tried to get a value for the solar temperature, but the results are too discordant to allow of much confidence. One of the chief observers

lowered his earlier estimate from 18,000,000° to 250,000° Fahr.[1] Other values range between 4,000,000° or 5,000,000° F., down to between 10,000° and 3,000°; the greatest artificial heat being possibly 4,000° F. However, of this we

[1] Fahr., or F., indicates the thermometer scale (named after its inventor, Fahrenheit) which is generally used in England. It has, however, the drawback of starting from a zero-point not sufficiently low, so that it is frequently exceeded by the cold of even an English winter. There are other scales — Reáumur's, used chiefly in France, marked R.; and that of Celsius, or the centigrade, much employed on the Continent, marked C. The latter especially has an advantage over that of Fahrenheit, in dividing the space between the two natural fixed points of freezing and boiling water into 100°, instead of the senseless 212° minus 32° of F. But this is more than counterbalanced by its so placing its zero at freezing, that we have continually to reckon both ways from it (worse still than in Fahrenheit), and the air may on one day stand at 5°, on the next at *minus* 5°—that is, 5° below zero. This may be so great a source of inconvenience that this scale is never likely to be adopted here. It may be useful to know how to convert the foreign scales into our own. For R. into F., multiply by 9, divide by 4, add 32. For C. into F., multiply by 9, divide by 5, add 32.

may be sure, that if the Sun were to draw as near to us as the Moon, our globe would flow down as wax before the fire. The heat, as the light, of the Sun is said to diminish from the centre to the limb.

The amount of light admits of a somewhat nearer estimate, and may be put equal to that of 6,300,000,000,000,000,000,000,000,000 candles, six to the pound, and those that can may get what idea they please out of that exercise in numeration. Or it may be 5,300 times brighter than the whitest possible melted iron, or 146 times than the lime light; the electric light alone is said to have been forced to fully half that of the Sun, but the experiment was not entirely satisfactory.

However, we have been somewhat wandering from our description of the visible aspect of the Sun, and it is time to return. The telescope refuses to guide us further, and leaves us

in a maze of perplexity and wonder; but another instrument, called the *spectroscope*, has been brought to its aid, and with results equally marvellous in their own way. Let us try to get some notion of its action. When a

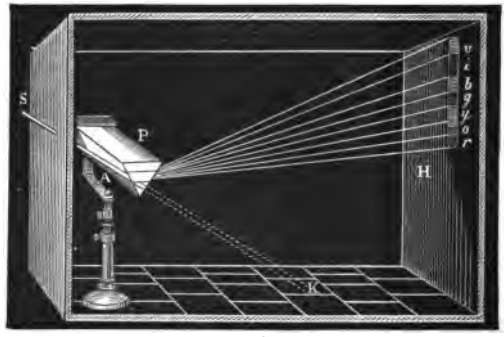


FIG. 10.

ray of common white light falls in a suitable direction upon a triangular piece of glass, called a *prism*, it is spread out into a long narrow band of bright colours, the colours of the rainbow, as in the accompanying diagram.

Here we have the inside of a darkened chamber, into which a beam of light, S, from the sun or any other source, is admitted through a small hole, and falls at A upon a prism, P, when, instead of passing on unchanged, as shown by the dotted lines, to K, it is *refracted*, or bent, out of its course by the prism, and at the same time *dispersed*, or spread out like a fan, into a long band of colours at H, upon the opposite wall. These colours are generally reckoned as seven—red at the lowest end and violet at the top, with orange, yellow, green, blue, and indigo (or dark blue) between them; but they are not sharply defined, and melt imperceptibly into one another from end to end. This band is called the *spectrum*. The order of the colours is always the same; but their number and selection vary according to the nature and source of the beam of light. Metals, or charcoal, or lime, or solid or fluid substances in

general, heated to whiteness, give out a *continuous* spectrum, as it is called, like the rainbow, where every colour melts into its neighbour without a break from end to end. And so does the Sun, but with this strange addition that, when magnified with certain precautions in the spectroscope, we find his spectrum full of dark hair-lines, more than 5,000 in the largest instruments, of various degrees of fineness, crossing the band from side to side, and each in a fixed place of its own on the sevenfold background of colours. Very strange, very unaccountable! But a key has been found to fit it, and it opens the door into a new region of wonders. A continuous spectrum is produced, as we said, when white-hot solid or fluid materials are the source of light, but vapours or gases behave in quite a different way. The chemist knows how to take the pressure of the atmosphere off them, and

heat them to incandescence—that is, shining without burning (which would destroy their essential character)—and then we may examine their light by a prism, especially in the spectroscope; and what shall we see? Instead of a long streak of colours, nothing but bright lines or bands, separated by intervals of darkness—the ribbon, in fact, cut across into strips of various breaths, often mere threads, each glowing with the colour due to its place had the spectrum been continuous. And, what is especially remarkable, every gas or vapour, when made incandescent, gives out lines or bands, more or fewer, thinner or thicker, peculiar to itself; so that when you see them you know at once what material causes them. Chemists reckon up between sixty and seventy elements[1]—that is, simple, uncompounded substances—

[1] The 'four elements of ancient days—fire, air, water, and earth—are not now considered elements at all.

and every one of these, in a state of incandescent vapour, has a spectrum of its own. Thus, the heated vapour of the curious metal, sodium, most rare as an element, most common as an ingredient in table salt and a multitude of other ordinary substances, gives out nothing but a thin yellow line, which large spectroscopes show double; and no other element shows a similar double yellow line; so that where you see that double yellow line, either alone or in a mixture of spectra, you may be sure that sodium is there. In the same way, four narrow and widely distant streaks—red, greenish blue, dark blue, and violet—show the presence of shining hydrogen gas; and the vapour of intensely heated iron produces a multitude of very narrow scattered lines of various colours; and so on for the other elements; so that while a continuous spectrum gives us no information as to its origin, an interrupted one tells us

where it comes from. Our key has opened the outer door; but there is another behind to be tried. It follows from experiment, as well as theory, that such heated vapours not only produce spectra of coloured lines, but that those same lines, especially if existing in cooler vapour, have the power of intercepting an identical breadth of the same colour in a continuous spectrum, if it happens to lie behind them—that is, whatever colour they give out, standing alone, that same they absorb or stifle if they act as a screen, so that in front of a brighter background they would be reversed from light to dark. Now, what did I tell you about the Sun? It is exactly what we find there—a blazing, continuous spectrum from the photosphere, that tells us nothing of its origin, crossed by a multitude of black hair-lines, of different degrees of fineness, each of which would have been luminous had it not been

reversed, and each one of which belongs to some one gas or vapour. Might not this lead us further? Would it be possible to heat some of our terrestrial vapours till they gave out their bright lines, and to bring them into the same field of view alongside the dark lines of the Sun, to see whether any of them might match? It is possible. It has been actually done. And with what result? In many cases the most perfect coincidence—so perfect that, astonishing as it seems, we are able to recognise elements familiar to us in daily life at a distance of 93,000,000 of miles, and to say confidently that they are present in the Sun. There we find, among the gases, hydrogen, for certain; among the metals, iron, sodium, magnesium, nickel, cobalt, calcium (the base of lime), with traces more or less satisfactory of many other elements—at least twenty-two in all. Still, it must be owned that in many cases

the correspondence is not quite clear, and, besides, there are many solar lines not as yet identified, and doubtless many elements up there of the nature of which we have not, and never shall have, any conception. It is surprising, indeed, to have been permitted to ascertain so much as to the constitution of such a body; nevertheless, 'hitherto shalt thou come, but no further.'

But will the spectroscope teach us nothing as to the nature of the spots? Generally speaking, the dark lines are thickened in them, showing increase of absorption, as if the vapour were cooler; and sometimes the middle of those thickened lines becomes bright, and occasionally there are curious twistings and misshapings of lines, indicating, it would seem, violent and rapid changes of place in the luminous material. But we are so unable to ascertain, or imitate in our chemistry, the

states of pressure and temperature at the surface of the Sun, that we must not hope to explain many of the processes there; only we can see that they show inconceivable activity and power.

When there happens to be a total eclipse of the Sun, from the Moon's just coming in front and hiding it as a round black patch, the bright coloured lines of the gases and vapours may be seen close to the Moon's edge, proving that they are always shining, though reversed at other times by the blaze of the photosphere behind them; but this beautiful appearance is very transient, owing to the rapid motion of the Moon across the Sun. But such an eclipse discloses other wonders round the edge of the darkened Sun.

Masses, usually of rosy, seldom white, light, called *prominences*, often large enough to be seen without the telescope, five or six or many

more at a time, of strange and irregular forms, but which have been compared to pyramids, and clouds, and horns, and flames, appear at different and distant points around the limb, varying entirely in each eclipse. They seem to be the loftiest parts of a shell of scarlet vapour averaging not more than 5,000 or 6,000 miles in thickness, called the *chromosphere* (properly *chromatosphere*), that encompasses the photosphere everywhere, but only thus becomes occasionally visible at its edge; and commonly with a jagged outline, whence it has been called the *sierra*. The spectroscope shows that this envelope and the prominences rising out of it consist chiefly of hydrogen gas, not burning as flame, which would imply change and combination into some other form, but heated up to shining in that wonderful furnace, where the temperature may probably keep every element in that 'dissociated' or uncombined state in which it is

seldom found here. But yet another marvel of modern days! It has been proved that, by a suitable arrangement of the telescope and spectroscope, so as to shut out the Sun's limb while we examine its immediate neighbourhood on the outside, these prominences may be seen and studied every fine day; and a wonderful sight they are, not only from their magnitude, often rising up 30,000 or 40,000 miles, and sometimes much higher, from the limb—one has been seen of 350,000 miles, not much less than half the breadth of the disc, that rose 10,000 times quicker than the speed of an express train —but also from their extraordinary and rapid changes. Some of them, indeed, float tranquilly like rosy clouds along or above the limb for days, especially towards the poles, where, unlike the spots, they are often to be found; and these seem to be generally composed of hydrogen. Others, which have been called

'eruptive prominences,' found more usually in the neighbourhood of spots, and containing the

FIG. 11.

vapours of magnesium, sodium, iron, and other metals, rise and sink, shoot out, divide, spread, and scatter in the most fantastic way, and

occasionally with a rapidity that has been known to reach 200 miles in a single second—

FIG. 12.—THE SAME GROUP TEN MINUTES LATER.

a rate of motion that would be elsewhere almost incredible, but here is only in keeping with the gigantic scale of the Sun. Some of

these changes are attempted to be represented, though of course very inadequately, in the preceding two delineations, taken only ten minutes apart; a third represents a quieter though still transient eruption.

But we must return to our few minutes of

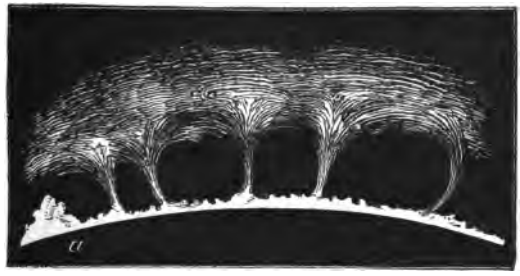


FIG. 13.

total eclipse, and, laying aside the telescope, look on the black Moon hanging in mid-heaven, and tipped with a few minute tongues of rosy fire. But we shall find that this is not all the phænomenon. There is a feeble yet still conspicuous whitish illumination spreading out

in every direction, brightest near the edge of the Moon, but rapidly fading away, with straight or curved or entangled streamers, and dark rifts, and irregular projections, and sometimes long rays, one of which has been known to extend to more than 6° in length. Its aspect varies in every eclipse. It sometimes gives light to read small print, in other eclipses is far less luminous; but is usually so obscure and confused in its details that observers, even on the same spot, do not agree in drawing or describing it. This is called the *corona*, and there have been long discussions as to its nature. There is no doubt that it belongs to the Sun, and it seems from the spectroscope to consist partly of some unknown gaseous element, partly of reflected light, as though that portion of space were filled with minute solid particles—which, in fact, have been described as a kind of dust. We can say little more

about it, but will show you three views of it in different eclipses, premising that it can only be well represented by a far more delicate mode of engraving, and also that the promi-

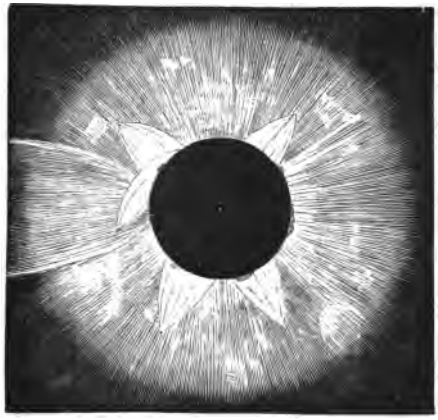


FIG. 14.—ECLIPSE OF 1842.

nences ought to be shown brighter than the corona, though the reverse is the case in these drawings.

There is yet another phænomenon connected with the Sun which may possibly be an ex-

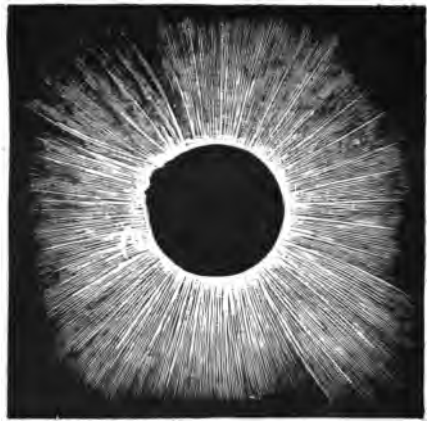


FIG. 15.—ECLIPSE OF 1858.

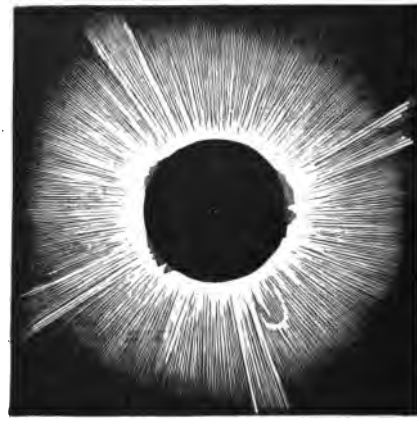


FIG. 16.—ECLIPSE OF 1860.

tension of the corona, though the point is not absolutely decided—the *zodiacal light*. This is a broad, tapering, rather yellowish beam, which appears before morning or after evening twilight, stretching through the sky nearly along the path which the Sun appears to follow, in consequence of the real motion of the Earth round him in her yearly orbit; and from this path, formerly called the *zodiac*, now the ecliptic, it takes its name. It is better observed from the equatorial parts of the Earth, but may be often seen in England towards the end of twilight in winter and spring, at a moderate height in the S.W. sky, slanting down in considerable breadth to the horizon, and pointing towards the Sun's place. In brightness it exceeds the fainter parts of the galaxy, is ill-defined at its edges, and when best seen is so long that it must, sometimes at least, sweep round the Earth and far beyond it

on the other side. It is not impossible that its unsuspected presence may be in some way beneficial to us, but its nature is quite unknown.

We have no more to learn in these pages about the Sun's luminous appendages; but our slight sketch (for it is nothing more) is not quite ended. Besides the familiar results of Light and Heat, there are two other powers—if, indeed, we may call them two—among the mightiest in the kingdom of God, which either spring from the Sun or obey his rule—*Electricity* and *Magnetism*. We are not going to give any account of these, in their secret but irresistible influence defying the research of man. We shall only observe that not only the daily movements of a very delicately suspended magnet distinctly point to the Sun as its master, but the irregular motions, called *magnetic storms*, which agitate it from time to time have, strange to say, periodical maxima and

minima corresponding with those of the sun-spots; and the singular outburst described in p. 53 not only immediately affected the magnet but disturbed the currents of electricity in the telegraphs in all parts of the world, and was followed by remarkable displays of the Aurora Borealis, even in places where they had scarcely ever been observed. It is evident, then, that there must be some hidden communication between these great powers on the Sun, the Earth, and probably every member of the solar system.

And then, another word. We talk of the *Fixed Stars*. But our instruments show that they are only comparatively fixed, and that, though their motions are very minute, they are unquestionable. We inquire which way they move; we might expect, as there is no obvious reason to the contrary, that it would be in all directions. But it is not. So large a proportion of their shifting points one way, as to

lead us to the inference that, after allowing for real and separate movements of their own, they must have a general apparent movement, occasioned by the Sun's flying through space the opposite way, and carrying with him ourselves and the whole of the system depending upon him. It may not be matter of absolute certainty, but there is great probability that such is the case; and that this motion of *translation*, as it is termed, through space, may take place at the rate of 150,000,000 miles every year —a movement utterly incomprehensible as to its cause, and equally so as to its purpose, but the more credible as we find so many of the brighter stars have similar motions; and there can be no doubt of the fact that this magnificent Sun, this mighty exhibition of Creative Power and Wisdom, is but one among the countless host of heaven;—is no other than a star!

INDEX.

PAGE

Axis of Sun inclined 39

Chromatosphere 67
Corona 72

Degree 13
Disc 27
Dispersion of light 59
Distance of Moon 34
„ Sun 25
Distances, how found 7

Earth, size of 14
Elements in Sun 64
Ellipse 29

Faculæ 41

Light of Sun 57

Magnetic Storms 77
Magnitude of Sun 31
Mars, the planet 23

PAGE

Nodes 21
Nucleus (of a spot) 45

Outbursts on Sun 53

Parallax 9
Penumbra (of a spot) 45
Photosphere 40
Prominences 66
Proportion of Solar System 16

Rotation of Sun 37

Shooting Stars 54
Spectroscope 58
Spectrum 59
Spots in Sun 35
„ nature of 49
„ views of 48
Sun, a star 79

Temperature of Sun 55
Thermometer scales . . . . 56, *note*
Transit of Venus 19, 24

Umbra (of a spot) 44

Zodiacal Light 75

Spottiswoode & Co., Printers, New-st. Square, London.

PATERNOSTER ROW, LONDON, E.C.

February 1885.

SELECT GENERAL LIST

OF

SCHOOL-BOOKS

PUBLISHED BY

MESSRS. LONGMANS & CO.

☞ The School-Books, Atlases, Maps, &c. comprised in this Catalogue may be inspected in the Educational Department of Messrs. LONGMANS & Co. 39 Paternoster Row, London, E.C. where also all other works published by them may be seen.

English Reading-Lesson Books.

Illustrated Readers in *Longmans' Modern Series*

Introductory Primer, pp. 24, with 33 Woodcuts, fcp. 8vo. price 2d. sewed.

Fourteen Reading-Sheets from the Primer, *3s. 6d.* per Set.

Primer, pp. 66, with 28 Woodcuts, *3d.* sewed, *4d.* cloth.

Book I. (Standard I.) pp. 128, with Woodcuts, cloth ..... *7d.*

Book II. (Standard II.) pp. 126, with 72 Woodcuts, cloth..... *8d.*

Book III. (Standard III.) pp. 192, with 90 Woodcuts, cloth..... *1s.*

Book IV. (Standard IV.) pp. 208, with 70 Woodcuts, cloth..... *1s. 2d.*

Book V. (Standard V.) pp. 320, with 80 Woodcuts, cloth..... *2s.*

Shakespeare's *Julius Cæsar*, Notes by T. Parry & Woodcuts, 12mo. ..... *1s.*

Selections from Shakespeare's *Julius Cæsar*, 12mo. ..... *3d.*

Shakespeare's *Merchant of Venice*, Notes by T. Parry & Woodcuts, 12mo. .. *1s.*

Selections from Shakespeare's *Merchant of Venice*, 12mo. ..... *3d.*

Shakespeare's *King John*, Notes by T. Parry & Woodcuts ..... *1s.*

Selections from Shakespeare's *King John*, 12mo..... *3d.*

Swift's Gulliver's Travels, Lilliput and Brobdingnag, Notes by Parry & 14 Woodcuts, 12mo. ..... *1s.*

Macaulay's Essay on Warren Hastings, Annotated by S. Hales, 12mo. .... *1s. 6d.*

Brassey's (Lady) A Voyage in the 'Sunbeam,' arranged as a Reading-Book, Illustrated, 12mo..... *2s.*

Isbister's First Steps in Reading and Learning, 12mo. ..... *1s. 6d.*

Laurie & Morell's Graduated Series of Reading-Lesson Books. Edited by J. D. Morell :—

Elementary Reading Book or Primer, 18mo. ..... *2d.*

Book I. pp. 144 ..... *8d.*
Book II. pp. 254 ..... *1s. 3d.*
Book III. pp. 312 ..... *1s. 6d.*
Book IV. pp. 446 ..... *2s.*
Book V. comprehending Readings in the best English Literature, pp. 496 ..... *2s. 6d.*

M'Leod's Reading Lessons for Infant Schools, 30 Broadside Sheets ..... *3s.*

— First School-Book to teach Reading and Writing, 18mo. ..... *6d.*

— Second School-Book to teach Spelling and Reading, 18mo. ..... *9d.*

Stevens & Hole's Introductory Lesson-Book, 18mo. ..... 6d.
— Grade Lesson-Book Primer, crown 8vo. ..... 3d.
— Grade Lesson-Books, in Six Standards, 12mo. :—

The First Standard, pp. 128 ..	9d.	The Fourth Standard, pp. 224 ..	1s. 3d.
The Second Standard, pp. 160	9d.	The Fifth Standard, pp. 224	1s. 3d.
The Third Standard, pp. 160	9d.	The Sixth Standard, pp. 260	1s. 6d.

Answers to the Arithmetical Exercises in Standards I. II. and III. price 4d. in Standard IV. price 4d. in Standards V. and VI. 4d. or complete, price 1s. 2d.

Sullivan's Literary Class-Book; Readings in English Literature, fcp..... 2s. 6d.

Writing Books.

Isbister's Three Engraved Account Books, oblong 4to. .....each 1s.
Johnston's Civil Service Specimens of Copying MSS. folio ..... 2s. 6d.
Tidmarsh's Copy-Books in *Longmans' Modern Series*, the Set of Thirteen Copy-Books, price .....each 2d.
*** An Edition of this Copy-Book can also be had in stiff covers, price 3d. each.

School Poetry Books.

Bilton's Poetical Reader for all Classes of Schools, fcp. ..... 1s. 3d.
Booth's Poetical Reader in *Longmans' Modern Series*, fcp. 8vo. with numerous Woodcuts, 1s. 6d. cloth, or with gilt edges ..... 2s.
Byron's Childe Harold, annotated by W. Hiley, M.A., fcp. 8vo..... 1s. 6d.
Goldsmith's Deserted Village, and Traveller, with Notes by W. M'Leod, each Poem, 12mo. ..... 1s. 6d.
Hughes's Select Specimens of English Poetry, 12mo. ..... 3s. 6d.
Hunter's Plays of Shakespeare, with Explanatory Notes, each Play 1s.

All's Well that Ends Well.	Julius Cæsar.	Othello.
Antony and Cleopatra.	King John.	Richard II.
As You Like it.	King Lear.	Richard III.
Comedy of Errors.	Love's Labour's Lost.	Romeo and Juliet.
Coriolanus.	Macbeth.	Taming of the Shrew.
Cymbeline.	Measure for Measure.	The Tempest.
Hamlet.	Merchant of Venice.	Timon of Athens.
Henry IV. 2 Parts.	Merry Wives of Windsor.	Troilus and Cressida.
Henry V.	Midsummer Night's Dream.	Twelfth-Night.
Henry VI. 3 Parts.	Much Ado about Nothing.	Two Gentlemen of Verona.
Henry VIII.		Winter's Tale.

Macaulay's Lays of Ancient Rome, with Ivry and the Armada, Popular Edition, with Illustrations by George Scharf, fcp. 4to. 6d. sewed, 1s. cloth.
Macaulay's Lays of Ancient Rome, with Ivry and the Armada, with Explanatory Notes, fcp. 8vo. 1s. sewed, 1s. 6d. cloth, ; or (*School Prize Edition*) 2s. 6d. bound in cloth extra, with gilt edges.
M'Leod's First Poetical Reading-Book, fcp. 8vo. ..... 9d.
— Second Poetical Reading-Book, fcp. 8vo. ..... 1s. 8d.
Milton's Samson Agonistes and Lycidas, by Hunter, 12mo. ..... 1s.
— Comus, L'Allegro and Il Penseroso, by Hunter, 12mo ..... 1s.
— Paradise Lost, by Hunter, I. to V. 1s. each.
— Paradise Regained, by Jerram, 18mo. ..... 2s. 6d.
Pope's Essay on Criticism & Moral Essays, by Arnold, fcp. 8vo. ..... 1s. 6d.
Scott's Marmion, by Morris, 12mo. ..... 2s. 6d.
Twell's Poetry for Repetition, comprising 200 short pieces, 18mo. ..... 1s. 6d.

English Spelling Books.

Johnson's Civil Service Spelling Book, fcp. ..... 1s. 3d.
Sewell's Dictation Exercises, First Series, 18mo. 1s. Second Series ..... 2s. 6d.
Sullivan's Spelling-Book Superseded, 18mo. ..... 1s. 4d.
— Words Spelled in Two or More Ways, 18mo. ..... 10d.

English Language & Literature, &c.

Arnold's English Poetry & Prose, crown 8vo ..... 6s.
— Manual of English Literature, crown 8vo. ..... 7s. 6d.
Bain's First or Introductory English Grammar, 18mo. ..... 1s. 4d.
— Higher English Grammar, fcp. 8vo. ..... 2s. 6d.
— Companion to English Grammar, crown 8vo. ..... 3s. 6d.
Brewer's Guide to English Composition, fcp. 8vo. ..... 3s. 6d.
Campbell's English Word-Study, fcp. 8vo. ..... 1s. 6d.
Edwards's History of the English Language, with Specimens, 18mo. ..... 9d.
Farrar's Language and Languages, crown 8vo. ..... 6s.
Fleming's Analysis of the English Language, crown 8vo. ..... 5s.
Graham's English, or the Art of Composition Explained, fcp. 8vo. ..... 5s.
Hiley's English Grammar and Style, 12mo. ..... 3s. 6d.
— — — Abridged, 18mo. ..... 1s. 9d.
— Child's First English Grammar, 18mo. ..... 1s.
— Exercises adapted to his English Grammar, 12mo. .... 2s. 6d. Key 4s. 6d.
— Practical English Composition, Part I. 18mo. ..... 1s. 6d. Key 2s. 6d.
— — — — Part II. 18mo. ..... 3s. Key 4s.
Hunter's Text-Book of English Grammar, 12mo. ..... 2s. 6d.
— Manual of Letter-Writing, 12mo. ..... 1s. 6d.
Isbister's English Grammar and Composition, 12mo. ..... 1s. 6d.
— First Book of Grammar, Geography, and History, 12mo. ..... 6d.
Johnston's English Composition and Essay-Writing, post 8vo. ..... 3s. 6d.
Latham's Handbook of the English Language, crown 8vo. ..... 6s.
— Elementary English Grammar, crown 8vo. ..... 3s. 6d.
Lowres's Grammar of English Grammars, 12mo. ..... 3s. 6d.
Macaulay's Essays and Lays of Ancient Rome, Authorised Edition, in 1 vol. 2s. 6d.
M'Leod's Explanatory English Grammar for Beginners, 18mo. ..... 9d.
— English Grammatical Definitions, for Home Study, 18mo. ..... 1d.
Marcet's Willy's Grammar for the use of Boys, 18mo. ..... 2s. 6d.
— Mary's Grammar, intended for the use of Girls, 18mo ..... 2s.
Morell's Essentials of English Grammar and Analysis, fcp. 8vo. ..... 8d.
— Grammar of the English Language, post 8vo. 2s. or with Exercises.. 2s. 6d.
— Graduated English Exercises, post 8vo. 8d. sewed or 9d. cloth.
Morgan's Key to Morell's Graduated Exercises, 12mo. ..... 4s.
— Learner's Companion to Morell's English Grammar, post 8vo. .... 6d.
Murison's First Work in English, fcp. 8vo. ..... 3s. 6d.
The Stepping-Stone to English Grammar, 18mo. ..... 1s.
Sullivan's Manual of Etymology, or First Steps to English, 18mo. ..... 10d.
— Attempt to Simplify English Grammar, 18mo. ..... 1s.

Paraphrasing, Parsing, and Analysis.

Hunter's Indexing & Précis of Correspondence, 12mo. ..... 3s. 6d.
— Introduction to Précis-Writing, 12mo. ..... 2s.
— Paraphrasing and Analysis of Sentences, 12mo. ..... 1s. 3d. Key 1s. 3d.
— Progressive Exercises in English Parsing, 12mo. ..... 6d.
— Questions on Paradise Lost, Books I. & II. 12mo. ..... 1s.
— Questions on the Merchant of Venice, 12mo. ..... 6d.
Johnston on Digesting Returns into Summaries, crown 8vo. ..... 1s. 3d.
— Civil Service Précis, 12mo. ..... 3s. 6d.
Jones's Text-Book on the Analysis of Sentences and Parsing, fcp. 8vo. ..... 2s.
Lowres's System of English Parsing and Derivation, 18mo. ..... 1s.
Morell's Analysis of Sentences Explained and Systematised, 12mo. ..... 2s.
Morgan's Training Examiner, First Course, 4d. Key, 1s. Second Course .. 1s.

Dictionaries and Manuals of Etymology.

Graham's English Synonyms, Classified and Explained, fcp. 8vo. ..... 6*s.*
Maunder's Scientific and Literary Treasury, fcp. 8vo. ..... 6*s.*
— Treasury of Knowledge and Library of Reference, fcp. 8vo. ..... 6*s.*
Sullivan's Dictionary of the English Language, 12mo. ..... 3*s.*
— Dictionary of Derivations, or Introduction to Etymology, fcp. ..... 2*s.*
Whately's English Synonyms, fcp. 8vo. ..... 3*s.*

Elocution.

Hughes's Select Specimens of English Poetry, 12mo. ..... 3*s.* 6*d.*
Isbister's Illustrated Public School Speaker and Reader, 12mo. ..... 3*s.* 6*d.*
— Lessons in Elocution, for Girls, 12mo. ..... 1*s.* 6*d.*
— Outlines of Elocution, for Boys, 12mo. ..... 1*s.* 6*d.*
Millard's Grammar of Elocution, fcp. 8vo. ..... 3*s.* 6*d.*
Rowton's Debater, or Art of Public Speaking, fcp. 8vo. ..... 6*s.*
Smart's Practice of Elocution, 12mo. ..... 4*s.*

Arithmetic.

Arithmetic in Seven Standards, in *Longmans' Modern Series*:—
STANDARD I. 1½*d.* paper, 2½*d.* cloth; STANDARDS II. to V. each 2*d.* paper, 3*d.* cloth; STANDARDS VI. & VII. 3*d.* each paper, 4*d.* each cloth.
ANSWERS, Standards I. to VII. price 2*d.* each.

Quarterly Arithmetical Test-Cards in *Longmans' Modern Series*:—
STANDARDS II. to VII. in 6 Packets of 24 Cards, 1*s.* each Packet, in paper, or in cloth ..... each 1*s.* 2*d.*

Anderson's Arithmetic for the Army, 18mo. ..... 1*s.*
Colenso's Arithmetic designed for the use of Schools, 12mo. ..... 4*s.* 6*d.*
Key to Colenso's Arithmetic for Schools, by Rev. J. Hunter, M.A. 12mo. ..... 5*s.*
Colenso's Shilling Elementary Arithmetic, 18mo. 1*s.* with Answers ..... 1*s.* 6*d.*

Arithmetic for National, Adult, and Commercial Schools:—
1. Text-Book, 18mo. ..... 6*d.*
2. Examples, Part I. Simple Arithmetic ..... 4*d.*
3. Examples, Part II. Compound Arithmetic 4*d.*
4. Examples, Part III. Fractions, Decimals, Duodecimals ..... 4*d.*
5. Answers to Examples, with Solutions of the difficult Questions ..... 1*s.*

Colenso's Arithmetical Tables, on a Card ..... 1*d.*
Harris's Graduated Exercises in Arithmetic and Mensuration, crown 8vo. 2*s.* 6*d.* or with Answers, 3*s*, the Answers separately, 9*d.* ..... Full Key 6*s.*
Hiley's Recapitulatory Examples in Arithmetic, 12mo. ..... 1*s.* 6*d.*
Hunter's Art of Solving Problems in Higher Arithmetic ..... 3*s.* 6*d.* Key 3*s.* 6*d.*
— Modern Arithmetic for School Work or Private Study, 12mo. 3*s.* 6*d.* Key 5*s.*
— New Shilling Arithmetic, 18mo. ..... 1*s.* Key 2*s.*
— Short Methods in Arithmetic, with Answers, 12mo. ..... 1*s.* 6*d.* Key 2*s.*
Isbister's Unitary Arithmetic, 12mo. 1*s.* or with Answers ..... 1*s.* 6*d.*
Johnston's Civil Service Arithmetic, 12mo. ..... 3*s.* 6*d.* Key 4*s.*
— Civil Service Tots, with Answers and Cross-Tots ..... 1*s.*
Liddell's Arithmetic, 18mo. 1*s* —or Two Parts ..... each 6*d.*
Lupton's Arithmetic for Schools and Candidates for Examination, 12mo. 2*s.* 6*d.* or with Answers, 3*s.* 6*d.* the Answers separately, 1*s.* ..... Key 6*s.*
— Examination-Papers in Arithmetic, crown 8vo. ..... 1*s.*
M'Leod's Manual of Arithmetic, containing 1,750 Questions, 18mo. ..... 2*d.*
— Mental Arithmetic, I. Whole Numbers, II. Fractions ..... each 1*s.*
— Extended Multiplication and Pence Tables. 18mo. 2*d*
Merrifield's Technical Arithmetic and Mensuration, small 8vo. 3*s.* 6*d.* ..... Key 3*s.* 6*d.*

Moffatt's Mental Arithmetic, 12mo. 1s. or with Key, 1s. 6d.
Tate's First Principles of Arithmetic, 12mo. ..... 1s. 6d.
Thomson's Arithmetic, 73rd Edit. by the Author's Sons, 12mo. 3s. 6d. ....Key 5s.
Wooding's Four Rules of Arithmetic, fcp. 8vo. .....1s. Key 1s.

Book-keeping, Economics, &c.

Hunter's Exercises in Book-keeping by Double Entry, 12mo. ....1s. 6d. Key 2s. 6d.
— Examination-Questions in Book-keeping by Double Entry, 12mo. .. 2s. 6d.
— Examination-Questions &c. as above, separate from the Answers .. 1s.
— Ruled Paper for Forms of Account Books, 5 sorts ..... per quire, 1s. 6d.
— Self-Instruction in Book-keeping, 12mo..... 2s.
— Studies in Double Entry, crown 8vo. ..... 2s.
— Supplementary Book-keeping by Double Entry, crown 8vo..... 3s.
Isbister's Book-keeping by Single and Double Entry, 18mo. ..... 9d.
— Set of Eight Account Books to the above .....each 6d.
Macleod's Economics for Beginners, small crown 8vo. ..... 2s. 6d.
— Elements of Banking, Sixth Edition, crown 8vo. ..... 5s.
— Elements of Economics, 2 vols. crown 8vo. ..... Vol. I. 7s. 6d.
Miller's Readings in Social Economy..... 2s.

Mensuration.

Boucher's Mensuration, Plane and Solid, 12mo. .....3s. Key 1s.
Hiley's Explanatory Mensuration, 12mo. ..... 2s. 6d.
Hunter's Elements of Mensuration, 18mo.....1s. Key 1s.
Merrifield's Technical Arithmetic & Mensuration, small 8vo. ....3s. 6d. Key 3s. 6d.
Nesbit's Treatise on Practical Mensuration, by Hunter, 12mo. .. 3s. 6d. Key 5s.

Algebra.

Bain's Algebraical Test Cards, 3 Packets, with Answers, 1s. each paper packet 1s. 4d. each, cloth case.
Colenso's Algebra, for National and Adult Schools, 18mo.....1s. 6d. Key 2s. 6d.
— Algebra, for the use of Schools, Part I. 12mo.....4s. 6d. Key 5s.
— Elements of Algebra, for the use of Schools, Part II. 12mo. 6s. Key 5s.
— Examples and Equation Papers, with the Answers, 12mo. ..... 2s. 6d.
— Student's Algebra, crown 8vo. .....6s. Key 6s.
Griffin's Algebra and Trigonometry, small 8vo. ..... 3s. 6d.
— Notes on Algebra and Trigonometry, small 8vo. ..... 3s. 6d.
Lund's Short and Easy Course of Algebra, crown 8vo. .....2s. 6d. Key 2s. 6d.
Potts's Elementary Algebra, 8vo. 6s. 6d. or in 12 Sections, 6d. each.
Reynolds's Elementary Algebra for Beginners, 18mo. 9d. Answers, 3d. Key 1s.
Tate's Algebra made Easy, 12mo.....2s. Key 3s. 6d.
Wood's Algebra, modernised by Lund, crown 8vo..... 7s. 6d.
— — Companion to, by Lund, crown 8vo. ..... 7s. 6d.

Geometry and Trigonometry.

Casey's Elements of Euclid, Books I. to VI. fcp. 8vo. ..... 4s. 6d.
— Sequel to Euclid, fcp. 8vo. ..... 3s. 6d.
Colenso's Elements of Euclid, 18mo. 4s. 6d. or with Key to the Exercises .... 6s. 6d.
— Geometrical Exercises and Key..... 3s. 6d.
— Geometrical Exercises, separately, 18mo. ..... 1s.
— Trigonometry, 12mo. Part I. 3s. 6d. Key 3s. 6d. Part II. 2s. 6d. Key 5s.
Griffin's Elementary Treatise on Plane Trigonometry, crown 8vo. ..... 2s. 6d.
Harvey's Euclid for Beginners, Books I. & II. 12mo. ..... 2s. 6d.
Hawtrey's Introduction to Euclid, fcp. 8vo..... 1s. 6d.
Hunter's Plane Trigonometry, for Beginners, 18mo.....1s. Key 9d.
— Treatise on Logarithms, 18mo. .....1s. Key 9d

Isbister's School Euclid, 12mo. BOOK I. price 1*s.* BOOKS I. & II. price 1*s.* 6*d.*
BOOKS I. to IV. price 2*s.* 6*d.*
Jeans's Plane and Spherical Trigonometry, 12mo. Part I. 5*s.*, Part II. 4*s.* or the 2 Parts in 1 vol. price 8*s.* 6*d.*
Potts's Euclid, University Edition, 8vo. ..... 10*s.*
— — Intermediate Edition, BOOKS I. to IV. 3*s.* BOOKS I. to III. 2*s.* 6*d.* BOOKS I. II. 1*s.* 6*d.* BOOK I. 1*s.*
— Enunciations of Euclid, 12mo. ..... 6*d.*
Salmon on Conic Sections, 6th Edition, 8vo. ..... 12*s.*
Tate's First Three Books of Euclid, 18mo. ..... 9*d.*
— Differential and Integral Calculus, 12mo. ..... 4*s.* 6*d.*
— Geometry, Mensuration, Trigonometry, &c. 12mo. ..... 3*s.* 6*d.*
— Practical Geometry, with 261 Woodcuts, 18mo. ..... 1*s.*
Thomson's Plane and Spherical Trigonometry, 8vo. ..... 4*s.* 6*d.*
Thomson's Differential and Integral Calculus, 12mo. ..... 5*s.* 6*d.*
Watson's Plane and Solid Geometry, small 8vo. ..... 3*s.* 6*d.*
Williamson on Differential Calculus, crown 8vo. ..... 10*s.* 6*d.*
— on Integral Calculus, crown 8vo. ..... 10*s.* 6*d.*
Wright's Elements of Plane Geometry, crown 8vo. ..... 5*s.*

Land Surveying, Drawing, and Practical Mathematics.

Binns's Orthographic Projection and Isometrical Drawing, 18mo ..... 1*s.*
Hulme's Worked Questions in Geometrical Drawing, super royal 8vo. ..... 7*s.* 6*d.*
Kimber's Graduation Mathematics, 8vo. 2*s.* or with Solutions, 6*s.* 6*d.*
— Mathematical Course for the University of London, 8vo. ..... 12*s.*
To be had in Two Parts, 6*s.* 6*d.* each. Key, in 2 Parts, 5*s.* each.
Milburn's Mathematical Formulæ for Candidates, post 8vo. ..... 3*s.* 6*d.*
Nesbit's Practical Land Surveying, 8vo. ..... 12*s.*
Salmon's Treatise on Conic Sections, 8vo. ..... 12*s.*
Winter's Mathematical Exercises, post 8vo. ..... 6*s.* 6*d.*
— Elementary Geometrical Drawing. Part I. post 8vo. 3*s.* 6*d.*; Part II. 6*s.* 6*d.*
Wrigley's Examples in Pure and Mixed Mathematics, 8vo. ..... 8*s.* 6*d.*

Musical Works by John Hullah, LL.D.

Hullah's Method of Teaching Singing, crown 8vo. ..... 2*s.* 6*d.*
— Exercises and Figures in the same, crown 8vo. ..... 1*s.* or 2 Parts, 6*d.* each.
Large Sheets, containing the Exercises in the same, Nos. 1 to XL. Five Parcels of Eight Sheets each ..... per Parcel 6*s.*
Chromatic Scale, with the Inflected Syllables, on Large Sheet ..... 1*s.* 6*d.*
Card of Chromatic Scale, price 1*d.*
Grammar of Musical Harmony, royal 8vo. Two Parts ..... each 1*s.* 6*d.*
Exercises to Grammar of Musical Harmony ..... 1*s.*
Grammar of Counterpoint. Part I. super-royal 8vo. ..... 2*s.* 6*d.*
Wilhem's Manual of Singing. Parts I. & II. 2*s.* 6*d.* or together ..... 5*s.*
Exercises and Figures contained in Parts I. & II. Books I. & II. ..... each 8*d.*
Large Sheets to Wilhem's Manual, Part I. Nos. I. to VIII. in a Parcel ..... 6*s.*
— — — — IX. to XL. 4 Parcels of 8 Nos. ... each 6*s.*
— — — — Part II. XLI. to LII. ..... 9*s.*
Hymns for the Young, set to Music, royal 8vo. ..... 8*d.*
Infant School Songs ..... 6*d.*
Notation, the Musical Alphabet, crown 8vo. ..... 6*d.*
Old English Songs for Schools, Harmonised ..... 6*d.*
Rudiments of Musical Grammar, royal 8vo. ..... 3*s.*
School Songs for 2 and 3 Voices. 2 Books, 8vo. ..... each 6*d.*

Longmans' Geographical Reading Books, edited by Rudler.

Introductory Book, by Stewart, fcp. 8vo. ..... 6*d.*
Human and Animal Life in the World, by G. A. Chisholm. [*In preparation.*
Physical Geography, by W. J. Stewart, B.A. fcp. 8vo. 9*d.*
The British Islands, by Thomas Parry, 1*s.* 3*d.*
The British Empire [*In preparation.*
The Countries of Europe and America, by G. A. Chisholm. [*In preparation.*
The Countries of Asia and Europe. [*In preparation.*

Political and Historical Geography.

Awdry's Mikra Hellas: an Outline of Classical Geography, crown 8vo ..... 9*d.*
Brassey's (Lady) A Voyage in the 'Sunbeam,' School Edition, fcp. 8vo. 2*s.*; School-Prize Edition, with gilt edges, 3*s.*
Butler's Ancient and Modern Geography, post 8vo. ..... 7*s.* 6*d.*
— Sketch of Modern Geography, post 8vo. ..... 4*s.*
— Sketch of Ancient Geography, post 8vo. ..... 4*s.*
Hiley's Child's First Geography, 18mo. ..... 9*d.*
— Elementary Geography for Beginners, 18mo. ..... 1*s.* 6*d.*
Hughes's Child's First Book of Geography, 18mo. ..... 9*d.*
— Geography of the British Empire, for Beginners, 18mo. ..... 9*d.*
— General Geography, for Beginners, 18mo. 9*d.* Questions, 9*d.*
— Manual of Geography, with Six Coloured Maps, fcp. 8vo. ..... 7*s.* 6*d.*
Or in Two Parts:—1. Europe, 3*s.* 6*d.* II. Asia, Africa, America, &c. 4*s.*
— Manual of British Geography, fcp. 8vo. ..... 2*s.*
Johnston's Competitive Geography of the World, post 8vo. ..... 5*s.*
— — — British Isles, post 8vo. ..... 1*s.* 6*d.*
— — Intermediate and General Geography ..... 1*s.*
Johnston's (Keith) Gazetteer, or Geographical Dictionary, 8vo. ..... 42*s.*
Lupton's Examination-Papers in Geography, crown 8vo. ..... 1*s.*
M'Leod's Geography of Palestine or the Holy Land, 12mo. ..... 1*s.* 6*d.*
Maunder's Treasury of Geography, fcp. 8vo. ..... 6*s.*
Stepping-Stone to Geography, 18mo. ..... 1*s.*
Sullivan's Geography Generalised, fcp. 2*s.* or with Maps, 2*s.* 6*d.*
— Introduction to Ancient and Modern Geography, 18mo. ..... 1*s.*

Physical Geography and Geology.

Hughes's (E.) Outlines of Physical Geography, 12mo. 3*s.* 6*d.* Questions, 6*d.*
— (W.) Physical Geography for Beginners, 18mo. ..... 1*s.*
Keith's Treatise on the Use of the Globes, 12mo. ..... 6*s.* 6*d.* Key 2*s.* 6*d.*
Proctor's Elementary Physical Geography, fcp. 8vo. ..... 1*s.* 6*d.*

School Atlases and Maps.

Butler's Atlas of Modern Geography, royal 8vo. ..... 10*s.* 6*d.*
— Junior Modern Atlas, comprising 12 Maps, royal 8vo. ..... 4*s.* 6*d.*
— Atlas of Ancient Geography, royal 8vo. ..... 12*s.*
— Junior Ancient Atlas, comprising 12 Maps, royal 8vo. ..... 4*s.* 6*d.*
— General Atlas, Modern & Ancient, royal 4to. ..... 22*s.*
Public Schools Atlas of Ancient Geography, 25 entirely New Coloured Maps, imperial 8vo. or imperial 4to. 7*s.* 6*d.* cloth.
Outline Maps of Greece and Palestine from the Same, 1*d.* each.
Public Schools Atlas of Modern Geography, 31 entirely New Coloured Maps, imperial 8vo. or imperial 4to. 5*s.* cloth.
Ten Outline Maps from the Same, 1*d.* each.
Public Schools Historical Atlas, 101 Maps and Plans (53 Coloured) 5*s.*
Four Outline Maps from the Same, 1*d.* each.

Natural History and Botany.

Edmonds's Elementary Botany, fcp. 8vo. Woodcuts ..... 2*s.*
Lindley and Moore's Treasury of Botany, Two Parts, fcp. 8vo. .....12*s.*
Macalister's Systematic Zoology of Vertebrates, 8vo. .....10*s.* 6*d.*
Maunder's Treasury of Natural History, revised by Holdsworth, fcp. 8vo..... 6*s.*
Owen's Natural History for Beginners, 18mo. Two Parts 9*d.* each, or 1 vol... 2*s.*
— Stepping-Stone to Natural History, 18mo. ..... 2*s.* 6*d.*
Or in Two Parts.—I. *Mammalia*, 1*s.* II. *Birds, Reptiles, and Fishes* .... 1*s.*
Wood's Bible Animals, 8vo. .....10*s.* 6*d.*
— Homes without Hands, 8vo. .....10*s.* 6*d.*
— Common British Insects, crown 8vo. ..... 3*s.* 6*d.*
— Insects at Home, 8vo. .....10*s.* 6*d.*
— Insects Abroad, 8vo. .....10*s.* 6*d.*
— Out of Doors, crown 8vo..... 5*s.*
— Petland Revisited, crown 8vo. ..... 7*s.* 6*d.*
— Strange Dwellings, crown 8vo. 5*s.* Popular Edition, 4to..... 6*d.*

Chemistry and Telegraphy.

Armstrong's Organic Chemistry, fcp. 8vo. ..... 3*s.* 6*d.*
Jago's Inorganic Chemistry, Theoretical and Practical, fcp. 8vo. ..... 2*s.*
Kolbe's Inorganic Chemistry, by Humpidge, crown 8vo..... 7*s.* 6*d.*
Miller's Introduction to Inorganic Chemistry, fcp. 8vo. ..... 3*s.* 6*d.*
Odling's Course of Practical Chemistry, for Medical Students, crown 8vo..... 6*s.*
Preece and Sivewright's Telegraphy, crown 8vo. ..... 5*s.*
Reynolds's Experimental Chemistry, PART I. 1*s.* 6*d.*; PART II. 2*s.* 6*d.*; PART III. 3*s.* 6*d.*
Tate's Outlines of Experimental Chemistry, 18mo. ..... 9*d.*
Thorpe's Quantitative Chemical Analysis, fcp. 8vo. ..... 4*s.* 6*d.*
Thorpe and Muir's Qualitative Chemical Analysis, fcp. 8vo. ..... 3*s.* 6*d.*
Tilden's Chemical Philosophy, fcp. 8vo. 3*s.* 6*d.* With Answers to Problems 4*s.* 6*d.*
— Practical Chemistry, Principles of Qualitative Analysis, fcp. 8vo..... 1*s.* 6*d.*

Text-Books of Science, Mechanical and Physical.

Abney's Treatise on Photography, fcp. 8vo..... 3*s.* 6*d.*
Anderson's Strength of Materials ..... 3*s.* 6*d.*
Armstrong's Organic Chemistry ..... 3*s.* 6*d.*
Ball's Elements of Astronomy ..... 6*s.*
Barry's Railway Appliances ..... 3*s.* 6*d.*
Bauerman's Systematic Mineralogy ..... 6*s.*
— Descriptive Mineralogy ..... 6*s.*
Bloxam and Huntington's Metals ..... 5*s.*
Glazebrook's Physical Optics ..... 6*s.*
Glazebrook and Shaw's Practical Physics ..... 6*s.*
Gore's Art of Electro-Metallurgy..... 6*s.*
Griffin's Algebra and Trigonometry ..... 3*s.* 6*d.*
Jenkin's Electricity and Magnetism ..... 3*s.* 6*d.*
Maxwell's Theory of Heat..... 3*s.* 6*d.*
Merrifield's Technical Arithmetic and Mensuration..... 3*s.* 6*d.*
Miller's Inorganic Chemistry ..... 3*s.* 6*d.*
Preece & Sivewright's Telegraphy ..... 5*s.*
Rutley's Study of Rocks, a Text-Book of Petrology ..... 4*s.* 6*d.*
Shelley's Workshop Appliances ..... 4*s.* 6*d.*
Thomé's Structural and Physiological Botany..... 6*s.*
Thorpe's Quantitative Chemical Analysis ..... 4*s.* 6*d.*
Thorpe and Muir's Qualitative Analysis ..... 3*s.* 6*d.*
Tilden's Chemical Philosophy. 3*s.* 6*d.* With Answers to Problems ..... 4*s.* 6*d.*
Unwin's Elements of Machine Design ..... 6*s.*
Watson's Plane and Solid Geometry ..... 3*s.* 6*d.*

Natural Philosophy and Natural Science.

Bloxam and Huntington's Metals, fcp. 8vo. ..... 5*s.*
Downing's Practical Hydraulics, Part I. 8vo. ..... 5*s.* 6*d.*
Everett's Vibratory Motion and Sound, 8vo. ..... 7*s.* 6*d.*
Ganot's Physics, translated by Prof. E. Atkinson, large crown 8vo. ..... 15*s.*
— Natural Philosophy, translated by the same, crown 8vo. ..... 7*s.* 6*d.*
Glazebrook and Shaw's Practical Physics, fcp. 8vo. ..... 6*s.*
Irving's Short Manual of Heat, fcp. 8vo. ..... 2*s.* 6*d.*
Jenkin's Electricity and Magnetism, fcp. 8vo. ..... 3*s.* 6*d.*
Maxwell's Theory of Heat, fcp. 8vo. ..... 3*s.* 6*d.*
Tate's Light & Heat, for the use of Beginners, 18mo. ..... 9*d.*
— Hydrostatics, Hydraulics, & Pneumatics, 18mo. ..... 9*d.*
— Electricity, explained for the use of Beginners, 18mo. ..... 9*d.*
— Magnetism, Voltaic Electricity & Electro-Dynamics, 18mo. ..... 9*d.*
Treglohan's Magnetism, 6*d.* sewed, 8*d.* cloth.
Tyndall's Lesson in Electricity, with 58 Woodcuts, crown 8vo. ..... 2*s.* 6*d.*
— Notes of Lectures on Electricity, 1*s.* sewed, 1*s.* 6*d.* cloth.
— Notes of Lectures on Light, 1*s.* sewed, 1*s.* 6*d.* cloth.

The London Science Class-Books.

Astronomy, by R. S. Ball, LL.D. F.R.S. ..... 1*s.* 6*d.*
Botany, Morphology and Physiology, by W. R. McNab, M.D. ..... 1*s.* 6*d.*
— the Classification of Plants, by W. R. McNab, M.D. ..... 1*s.* 6*d.*
Geometry, Congruent Figures, by O. Henrici, F.R.S. ..... 1*s.* 6*d.*
Hydrostatics and Pneumatics, by P. Magnus, B.Sc. 1*s.* 6*d.* or with Answers 2*s.* Worked Key 2*s.*
Laws of Health, by W. H. Corfield, M.A. M.D. ..... 1*s.* 6*d.*
Mechanics, by R. S. Ball, LL.D. F.R.S. ..... 1*s.* 6*d.*
Practical Physics: Molecular Physics and Sound, by F. Guthrie, F.R.S. ..... 1*s.* 6*d.*
Thermodynamics, by R. Wormell, M.A. D.Sc. ..... 1*s.* 6*d.*
Zoology of Vertebrate Animals, by A. McAlister, M.D. ..... 1*s.* 6*d.*
Zoology of Invertebrate Animals, by A. McAlister, M.D. ..... 1*s.* 6*d.*

Mechanics & Mechanism.

Barry's Railway Appliances, fcp. 8vo. Woodcuts. ..... 3*s.* 6*d.*
Goodeve's Elements of Mechanism, crown 8vo. ..... 6*s.*
— Principles of Mechanics, crown 8vo. ..... 6*s.*
Magnus's Lessons in Elementary Mechanics, fcp. 8vo. ..... 3*s.* 6*d.*
Shelley's Workshop Appliances, small 8vo. ..... 4*s.* 6*d.*
Tate's Elements of Mechanism, 12mo. ..... 3*s.* 6*d.*
— Exercises on Mechanics and Natural Philosophy, 12mo. ..... 2*s.* Key 3*s.* 6*d.*
— Mechanics and the Steam-Engine, for Beginners, 18mo. ..... 9*d.*
Twisden's Introduction to Practical Mechanics, crown 8vo. ..... 10*s.* 6*d.*
— First Lessons in Theoretical Mechanics, crown 8vo. ..... 8*s.* 6*d.*

Popular Astronomy & Navigation.

Ball's Elements of Astronomy, fcp. 8vo. ..... 6*s.*
Brinkley's Astronomy, by Stubbs & Brunnow, crown 8vo. ..... 6*s.*
Evers's Navigation & Great Circle Sailing, 18mo. ..... 1*s.*
Herschel's Outlines of Astronomy, Twelfth Edition, square crown 8vo. ..... 12*s.*
Jeans's Handbook for the Stars, royal 8vo. ..... 4*s.* 6*d.*
— Navigation and Nautical Astronomy, royal 8vo. Part I. *Practical*, 7*s.* 6*d.* Part II. *Theoretical*, 7*s.* 6*d.* or the 2 Parts in 1 vol. price 14*s.*
Kimber's Elementary Astronomy, 8vo. ..... 2*s.* 6*d.*
Laughton's Nautical Surveying, fcp. 8vo. ..... 6*s.*
Merrifield's Treatise on Navigation, crown 8vo. ..... 5*s.*

Proctor's Lessons in Elementary Astronomy, fcp. 8vo. ..... 1s. 6d.
— Library Star Atlas folio ..... 15s.
— New Star Atlas for Schools, crown 8vo. ..... 5s.
Stepping-Stone to Astronomy, 18mo. ..... 1s.
Tate's Astronomy and the use of the Globes, for Beginners, 18mo. ..... 9d.
Webb's Celestial Objects for Common Telescopes, crown 8vo. ..... 9s.

Animal Physiology & Preservation of Health.

Bray's Education of the Feelings, crown 8vo. ..... 2s. 6d.
— Physiology and the Laws of Health, fcp. 8vo ..... 1s.
— Science of Man, crown 8vo. ..... 6s.
Buckton's Food and Home Cookery, crown 8vo. ..... 2s. 6d.
— Health in the House, crown 8vo. ..... 2s.
Corfield's Laws of Health, fcp. 8vo. ..... 1s. 6d.
House I Live In; Structure and Functions of the Human Body, 18mo. ..... 2s. 6d.
Mapother's Animal Physiology, 18mo ..... 1s.

General Knowledge & Chronology.

Slater's *Sententiæ Chronologicæ*, the Original Work, 12mo. ..... 1s. 6d.
— — — improved by Miss Sewell, 12mo. ..... 3s. 6d.
Stepping-Stone (The) to Knowledge, 18mo ..... 1s.
Second Series of the Stepping-Stone to General Knowledge, 18mo. ..... 1s.
Sterne's Questions on Generalities, Two Series, each 2s. Keys ..... each 4s.

Mythology & Antiquities.

Hort's New Pantheon, 18mo. with 17 Plates ..... 2s. 6d.
Rich's Illustrated Dictionary of Roman and Greek Antiquities, post 8vo. .... 7s. 6d.
Witt's Myths of Hellas, translated by Younghusband, crown 8vo. ..... 3s. 6d.
— The Trojan War do. do. crown 8vo. ..... 2s.
— The Wanderings of Ulysses do. do. crown 8vo. (*In the press.*) 2s.

Biography.

Gleig's Life of the Duke of Wellington, crown 8vo. ..... 6s.
Macaulay's Clive, annotated by H. C. Bowen, M.A. fcp. 8vo. ..... 2s. 6d.
— Warren Hastings, annotated by S. Hales, fcp. 8vo. ..... 1s. 6d.
Maunder's Biographical Treasury, re-written by W. L. R. Cates, fcp. 8vo .... 6s.
Stepping-Stone (The) to Biography, 18mo. ..... 1s.

English History Reading Books.

Standard II. Old Stories from British History, by F. York Powell, M.A., with 19 Woodcuts ..... 6d.
III. Alfred the Great and William the Conqueror, by F. York Powell, M.A., with 9 Woodcuts ..... 8d.

First Series.
Without Annotations or other Aids:

IV. Outlines of English History from B.C. 55 to A.D. 1603, by S. R. Gardiner, with 47 Woodcuts and Maps, 1s.
V. Outlines of English History, Second Period, from 1603-1880, by S. R. Gardiner, with 40 Woodcuts and Maps, 1s. 6d.
VI. Historical Biographies, by S. R. Gardiner, with 40 Portraits and other Illustrations, 1s. 6d.

Alternative Series, in larger type and on thicker paper, with Vocabularies, Annotations, and Analyses:

IV. Illustrated English History, Part I. from B.C. 55 to A.D. 1485, by S. R. Gardiner, 1s.
V. Illustrated English History, Part II. from 1485 to 1689, by S. R. Gardiner, 1s. 3d.
VI. Illustrated English History, Part III. from 1689 to 1880, by S. R. Gardiner, 1s. 6d.

VII. The English Citizen and the English State, by F. York Powell, M.A. [*In preparation.*

Epochs of Modern History.

Church's Beginning of the Middle Ages, fcp. 8vo. Maps ..... 2s. 6d.
Cox's Crusades, fcp. 8vo. Maps ..... 2s. 6d.
Creighton's Age of Elizabeth, fcp. 8vo. Maps ..... 2s. 6d.
Gairdner's Houses of Lancaster & York, fcp. 8vo. Maps ..... 2s. 6d.
Gardiner's Thirty Years' War, 1618–1648, fcp. 8vo. Maps ..... 2s. 6d.
— First Two Stuarts and the Puritan Revolution, fcp. 8vo. Maps .... 2s. 6d.
— (Mrs.) French Revolution, 1789–1795, Maps ..... 2s. 6d.
Hale's Fall of the Stuarts, fcp. 8vo. Maps ..... 2s. 6d.
Johnson's Normans in Europe, fcp. 8vo. Maps ..... 2s. 6d.
Longman's Frederick the Great and the Seven Years' War, fcp. 8vo. Maps .. 2s. 6d.
Ludlow's War of American Independence, fcp. 8vo. Maps ..... 2s. 6d.
McCarthy's Epoch of Reform, 1830–1850 ..... 2s. 6d.
Morris's Age of Anne, fcp. 8vo. Maps ..... 2s. 6d.
Seebohm's Protestant Revolution, fcp. 8vo. Maps ..... 2s. 6d.
Stubbs's Early Plantagenets, fcp. 8vo. Maps ..... 2s. 6d.
Warburton's Edward the Third, fcp. 8vo. Maps ..... 2s.

Epochs of English History.

Creighton's Shilling History of England, Introductory, fcp. 8vo. ..... 1s.
Browning's Modern England, from 1820 to 1874 .....
Creighton's England a Continental Power, 1066–1216, fcp. Maps ..... 9d.
— Tudors and the Reformation, 1485–1603, fcp. 8vo. Maps ..... 9d.
Gardiner's Struggle against Absolute Monarchy, 1603–1688, fcp. Maps ..... 9d.
Powell's Early England to the Norman Conquest, fcp. 8vo. Maps ..... 1s.
Rowley's Rise of the People and Growth of Parliament, 1215–1485, fcp. Maps 9d.
— Settlement of the Constitution, 1689–1784, fcp. Maps ..... 9d.
Tancock's England during the Revolutionary Wars, 1765–1820 ..... 9d.
Epochs of English History, complete in 1 vol. fcp. 8vo. ..... 5s.

Epochs of Ancient History.

Beesly's Gracchi, Marius and Sulla, fcp. 8vo. Maps ..... 2s. 6d.
Capes's Age of the Antonines, fcp. 8vo. Maps ..... 2s. 6d.
— Early Roman Empire, fcp. 8vo. Maps ..... 2s. 6d.
Cox's Athenian Empire, fcp. 8vo. Maps ..... 2s. 6d.
— Greeks & Persians, fcp. 8vo. Maps ..... 2s. 6d.
Curtels's Rise of the Macedonian Empire, fcp. 8vo. Maps ..... 2s. 6d.
Ihne's Rome to its Capture by the Gauls, fcp. 8vo. Maps ..... 2s. 6d.
Merivale's Roman Triumvirates, fcp. 8vo Maps ..... 2s. 6d.
Sankey's Spartan and Theban Supremacies, fcp. 8vo. Maps ..... 2s. 6d.
Smith's Rome and Carthage, the Punic Wars, fcp. 8vo. Maps ..... 2s. 6d.

English History & Constitution.

Amos's Primer of English Constitution and Government, crown 8vo. ..... 6s.
Bartle's Synopsis of English History, fcp. 8vo. ..... 3s. 6d.
Cantlay's English History Analysed, fcp. 8vo. ..... 2s.
Catechism of English History, edited by Miss Sewell, 18mo. ..... 1s. 6d.
Epochs of English History, edited by Creighton, fcp. 8vo. ..... 5s.
Gardiner's Outline of English History, fcp. 8vo. Woodcuts and Maps 2s. 6d
Gleig's First Book of History—England, 18mo. 2s. or Two Parts, 9d. each.
— British Colonies, or Second Book of History, 18mo. 1s
— British India, or Third Book of History, 18mo. 9d
— Historical Questions on the above Three Histories, 18mo. 9d

Littlewood's Essentials of English History, fcp. 8vo. ..... 3s.
Lupton's School English History, crown 8vo. ..... 7s. 6d.
— Concise English History for Civil Service Candidates, crown 8vo. .. 3s. 6d.
— Examination-Papers in History, crown 8vo. ..... 1s.
Macaulay's History of England, Student's Edition, 2 vols. crown 8vo. ..... 12s.
Morris's Class-Book History of England, fcp. 8vo. ..... 3s. 6d.
— Senior Standard History Readers, I. and II. 1s. 6d. each; III. 1s. 9d.
Rannie's Outline of the English Constitution, fcp. 8vo. ..... 2s. 6d.
Stepping-Stone to English History, 18mo. ..... 1s.

History, Ancient & Modern.

Browne's History of Greece, for Beginners, 18mo. ..... 9d.
— History of Rome, for Beginners, 18mo. ..... 9d.
Cox's General History of Greece, crown 8vo. ..... 7s. 6d.
Gleig's History of France, 18mo. ..... 1s.
Mangnall's Historical and Miscellaneous Questions, 12mo. ..... 2s. 6d.
Maunder's Historical Treasury, with Index, fcp. 8vo. ..... 6s.
Merivale's General History of Rome, crown 8vo. Maps ..... 7s. 6d.
Puller's School History of Rome, abridged from Merivale, fcp. Maps ..... 3s. 6d.
Sewell's Ancient History of Egypt, Assyria, and Babylonia, fcp. 8vo. ..... 6s.
— Catechism of Grecian History, 18mo. ..... 1s. 6d.
— Child's First History of Rome, fcp. 8vo. ..... 2s. 6d.
— First History of Greece, fcp. 8vo. ..... 3s. 6d.
— Popular History of France, crown 8vo. ..... 7s. 6d.
Stepping-Stone to Grecian History, 18mo. ..... 1s.
Stepping-Stone to Roman History, 18mo. ..... 1s.
Taylor's Student's Manual of Ancient History, crown 8vo. ..... 7s. 6d.
— Student's Manual of Modern History, crown 8vo. ..... 7s. 6d.
— Student's Manual of the History of India, crown 8vo. ..... 7s. 6d.

Scripture History, Moral & Religious Works.

Ayre's Treasury of Bible Knowledge, fcp. 8vo. ..... 6s.
Boultbee's Commentary on the Thirty-nine Articles, crown 8vo. ..... 6s.
Bray's (Mrs.) Elements of Morality, fcp. 8vo. ..... 2s. 6d.
Browne's Exposition of the Thirty-Nine Articles, 8vo. ..... 16s.
Examination Questions on the above, by Gorle, fcp. 8vo. ..... 3s. 6d.
Conder's Handbook to the Bible, post 8vo. Maps, &c. ..... 7s. 6d.
Conybeare and Howson's Life and Epistles of St. Paul, 1 vol. crown 8vo. .... 7s. 6d.
Gleig's Sacred History, or Fourth Book of History, 18mo. 2s. or 2 Parts, each 9d.
Norris's Catechist's Manual, 18mo. ..... 1s. 3d.
Potts's Paley's Evidences and Horæ Paulinæ, 8vo. ..... 10s. 6d.
Riddle's Manual of Scripture History, fcp. 8vo. 4s. Outlines of ditto ..... 2s. 6d.
Rogers's School and Children's Bible, crown 8vo. ..... 2s.
Sewell's Preparation for the Holy Communion, 32mo. ..... 3s.
Stepping-Stone to Bible Knowledge, 18mo. ..... 1s.
Whately's Introductory Lessons on Christian Evidences, 18mo. ..... 6d.
Auden's Analysis of ditto, 6d. Joly's Questions on ditto, 2d.

Mental & Moral Philosophy.

Abbott's Elements of Logic, 2s. 6d. sewed, or 3s. cloth.
Bacon's Essays, with Annotations by Archbishop Whately, 8vo. ..... 10s. 6d.
— — annotated by Hunter, crown 8vo. ..... 3s. 6d.
— — annotated by Abbott, 2 vols. fcp. 8vo. ..... 6s.

Bain's Rhetoric and English Composition, crown 8vo..... 4s.
— Mental and Moral Science, crown 8vo.....10s. 6d.
Killick's Student's Handbook of Mill's System of Logic, crown 8vo. ..... 3s. 6d.
Morell's Handbook of Logic, for Schools and Teachers, fcp. 8vo. ..... 2s.
Stebbing's Analysis of Mill's Logic, 12mo. ..... 3s. 6d.
Sully's Psychology, with reference to the Theory of Education, 8vo. .....12s. 6d.
Swinburne's Picture Logic, crown 8vo..... 5s.
Thomson's Outline of the Necessary Laws of Thought, post 8vo..... 6s.
Whately's Elements of Logic, 8vo. 10s. 6d. crown 8vo..... 4s. 6d.
— Elements of Rhetoric, 8vo. 10s. 6d. crown 8vo..... 4s. 6d.
— Lessons on Reasoning, fcp. 8vo..... 1s. 6d.

Principles of Teaching, &c.

Crawley's Handbook of Competitive Examinations crown 8vo..... 2s. 6d.
Gill's Text-Book of Education, Method and School Management, fcp. 8vo. .. 3s.
— Systems of Education, fcp. 8vo. ..... 2s. 6d.
— Art of Religious Instruction, fcp. 8vo. ..... 2s.
— Art of Teaching to Observe and Think, fcp. 8vo. ..... 2s.
— Locke's Principles of Education, fcp. 8vo..... 1s.
Hewitt's Simple Object Lessons for Infants, fcp. 8vo. First and Second Series..... each 8d.
Johnston's (R.) Civil Service Guide, crown 8vo..... 3s. 6d.
Lake's Book of Oral Object Lessons on Common Things, 18mo..... 1s. 6d.
Potts's Account of Cambridge Scholarships and Exhibitions, crown 8vo. .... 5s.
Robinson's Manual of Method and Organisation, fcp. 8vo. ..... 3s. 6d.
Sewell's Principles of Education, 2 vols. fcp. 8vo.....12s. 6d.
Sullivan's Papers on Education and School-Keeping, 12mo..... 2s.

White's Grammar-School Greek Texts.

Æsop (Fables) & Palæphatus (Myths), 32mo.....Price 1s.
Homer, Iliad, Book I. ..... 1s.
— Odyssey, Book I..... 1s.
Lucian, Select Dialogues ..... 1s.
Xenophon, Anabasis, Books I. III. IV. V. & VI. 1s. 6d. each; Book II. 1s.; Book VII. 2s.
Xenophon, Book I. without Vocabulary ..... 3d.
St. Matthew's and St. Luke's Gospels, 2s. 6d. each.
St. Mark's and St. John's Gospels, 1s. 6d. each.
The Acts of the Apostles ..... 2s. 6d.
St. Paul's Epistle to the Romans 1s. 6d.
The Four Gospels in Greek, with Greek-English Lexicon. Edited by John T. White, D.D. Oxon. Square 32mo. price 5s.

White's Grammar-School Latin Texts.

Cæsar, Gallic War, Books I. & II. V. & VI. 1s. each. Book I. without Vocabulary, 8d.
Cæsar Gallic War, Books III. & IV. 9d. each.
Cæsar, Gallic War, Book VII.... 1s. 6d.
Cicero, Cato Major (Old Age).... 1s. 6d.
Cicero, Lælius (Friendship) .... 1s. 6d.
Eutropius, Roman History, Books I. & II. 1s. Books III. & IV. 1s.
Horace, Odes, Books I. II. & IV. 1s. each.
Horace, Odes, Book III. ..... 1s. 6d.
Horace, Epodes & Carmen Seculare 1s.
Nepos, Miltiades, Simon, Pausanias, Aristides..... 9d.
Ovid, Selections from Epistles and Fasti ..... 1s.
Ovid, Select Myths from Metamorphoses ..... 9d.
Phædrus, Select Easy Fables.... 9d.
Phædrus, Fables, Books I. & II.. 1s.
Sallust, Bellum Catilinarium.... 1s. 6d.
Virgil, Georgics, Book IV..... 1s.
Virgil, Æneid, Books I. to VI..1s. each.
Book I. without Vocabulary .. 3d.
Virgil, Æneid, Books VII. VIII. X. XI. XII. .....1s. 6d. ea.

Livy, Books XXII. and XXIII. The Latin Text with English Explanatory and Grammatical Notes, and a Vocabulary of Proper Names. Edited by John T. White, D.D. Oxon. 12mo. price 2s. 6d. each Book.

The Greek Language.

Bloomfield's College and School Greek Testament, fcp. 8vo. ..... 5s.
Bolland & Lang's Politics of Aristotle, post 8vo. ..... 7s. 6d.
Collis's Chief Tenses of the Greek Irregular Verbs, 8vo. ..... 1s.
— Pontes Græci, Stepping-Stone to Greek Grammar, 12mo. ..... 3s. 6d.
— Praxis Græca, Etymology, 12mo. ..... 2s. 6d.
— Greek Verse-Book, Praxis Iambica, 12mo. ..... 4s. 6d.
Farrar's Brief Greek Syntax and Accidence, 12mo. ..... 4s. 6d.
— Greek Grammar Rules for Harrow School, 12mo. ..... 1s. 6d.
Hewitt's Greek Examination-Papers, 12mo. ..... 1s. 6d.
Isbister's Xenophon's Anabasis, Books I. to III. with Notes, 12mo. ..... 3s. 6d.
Jerram's Græcè Reddenda, crown 8vo. ..... 1s. 6d.
Kennedy's Greek Grammar, 12mo. ..... 4s. 6d.
Liddell & Scott's English-Greek Lexicon, 4to. 36s. Square 12mo. ..... 7s. 6d.
Linwood's Sophocles, Greek Text, Latin Notes, 4th Edition, 8vo. ..... 16s.
Mahaffy's Classical Greek Literature, cr. 8vo. Poets, 7s. 6d. Prose Writers 7s. 6d.
Morris's Greek Lessons, square 18mo. ..... Part I. 2s. 6d. Part II. 1s.
Parry's Elementary Greek Grammar, 12mo. ..... 3s. 6d.
Plato's Republic, Book I. Greek Text, English Notes by Hardy, crown 8vo. ... 3s.
Sheppard and Evans's Notes on Thucydides, crown 8vo. ..... 7s. 6d.
Thucydides, Book IV. with Notes by Barton and Chavasse, crown 8vo. .... 5s.
Valpy's Greek Delectus, improved by White, 12mo. 2s. 6d. ..... Key 2s. 6d.
White's Xenophon's Expedition of Cyrus, with English Notes, 12mo. ..... 7s. 6d.
Wilkins's Manual of Greek Prose Composition, crown 8vo. ..... 5s. Key 5s.
— Exercises in Greek Prose Composition, crown 8vo. .... 4s. 6d. Key 2s. 6d.
— New Greek Delectus, crown 8vo. ..... 3s. 6d. Key 2s. 6d.
— Progressive Greek Delectus, 12mo. ..... 4s. Key 2s. 6d.
— Progressive Greek Anthology, 12mo. ..... 5s.
— Scriptores Attici, Excerpts with English Notes, crown 8vo. ..... 7s. 6d.
— Speeches from Thucydides translated, post 8vo. ..... 6s.
Yonge's English-Greek Lexicon ..... 4to. 21s. Square 12mo. 8s. 6d.

The Latin Language.

Bradley's Latin Prose Exercises, 12mo. ..... 3s. 6d. Key 5s.
— Continuous Lessons in Latin Prose, 12mo. ..... 5s. Key 5s. 6d.
— Cornelius Nepos, improved by White, 12mo. ..... 3s. 6d.
— Ovid's Metamorphoses, improved by White, 12mo. ..... 4s. 6d.
— Select Fables of Phædrus, improved by White, 12mo. ..... 2s. 6d.
— Eutropius, improved by White, 12mo. ..... 2s. 6d.
Collis's Chief Tenses of Latin Irregular Verbs, 8vo. ..... 1s.
— Pontes Latini, Stepping-Stone to Latin Grammar, 12mo. ..... 3s. 6d.
Hewitt's Latin Examination-Papers, 12mo. ..... 1s. 6d.
Isbister's Cæsar, Books I.–VII. 12mo. 4s. or with Reading Lessons ..... 4s. 6d.
— Cæsar's Commentaries, Books I.–V. 12mo. ..... 3s. 6d.
— First Book of Cæsar's Gallic War, 12mo. ..... 1s. 6d.
Jeffcott Tossell's Helps for Latin Students, fcp. 8vo. ..... 2s.
Jerram's Latinè Reddenda, crown 8vo. ..... 1s. 6d.

Kennedy's Child's Latin Primer, or First Latin Lessons, 12mo. ..... 2s.
— Child's Latin Accidence, 12mo. ..... 1s.
— Elementary Latin Grammar, 12mo. ..... 3s. 6d.
— Elementary Latin Reading Book, or Tirocinium Latinum, 12mo... 2s.
— Latin Prose, Palæstra Stili Latini, 12mo. ..... 6s.
— Subsidia Primaria, Exercise Books to the Public School Latin Primer. I. Accidence and Simple Construction, 2s. 6d. II. Syntax 3s. 6d.
— Key to the Exercises in Subsidia Primaria, Parts I. & II. price 5s.
— Subsidia Primaria, III. the Latin Compound Sentence, 12mo. .... 1s.
— Curriculum Stili Latini, 12mo. .....4s. 6d. Key 7s. 6d.
— Palæstra Latina, or Second Latin Reading-Book, 12mo. ..... 5s.
Kenny's Virgil's Æneid, Books I. II. III. & V. 18mo. .....each Book 1s.
Millington's Latin Prose Composition, crown 8vo. ..... 3s. 6d.
— Selections from Latin Prose, crown 8vo. ..... 2s. 6d.
Moody's Eton Latin Grammar, 12mo. 2s. 6d. The Accidence separately .... 1s.
Morris's Elementa Latina, fcp. 8vo.....1s. 6d. Key 2s. 6d.
Parry's Origines Romanæ, from Livy, with English Notes, crown 8vo. ..... 4s.
The Public School Latin Primer, 12mo. ..... 2s. 6d.
— — — — Grammar, by Rev. Dr. Kennedy, post 8vo. ..... 7s. 6d.
Prendergast's Mastery Series, Manual of Latin, 12mo. ..... 2s. 6d.
Rapier's Introduction to Composition of Latin Verse, 12mo. ....3s. 6d. Key 2s. 6d.
Riddle's Young Scholar's Lat.-Eng. & Eng.-Lat. Dictionary, square 12mo. ..10s. 6d.
Separately { The Latin-English Dictionary, 6s. / The English-Latin Dictionary, 5s.
Sheppard and Turner's Aids to Classical Study, 12mo.....5s. Key 6s.
Valpy's Latin Delectus, improved by White, 12mo.....2s. 6d. Key 3s. 6d.
Virgil's Æneid, translated into English Verse by Conington, crown 8vo..... 9s.
— Works, edited by Kennedy, crown 8vo.....10s. 6d.
— — translated into English Prose by Conington, crown 8vo. .... 9s.
Walford's Progressive Exercises in Latin Elegiac Verse, 12mo. ..2s. 6d. Key 5s.
White and Riddle's Large Latin-English Dictionary, 1 vol. 4to.....21s.
White's Concise Latin-English Dictionary for University Students, royal 8vo.12s.
White's Junior Students' Eng.-Lat. & Lat.-Eng. Dictionary, square 12mo.... 5s.
Separately { The Latin-English Dictionary, price 3s. / The English-Latin Dictionary, price 3s.
Wilkins's Progressive Latin Delectus, 12mo. ..... 2s.
— Easy Latin Prose Exercises, crown 8vo. .....2s. 6d. Key 2s. 6d.
— Manual of Latin Prose Composition, crown 8vo. .....4s. 6d. Key 2s. 6d.
— Latin Prose Exercises, crown 8vo.....4s. 6d. Key 5s.
— Rules of Latin Syntax, 8vo. ..... 2s.
— Notes for Latin Lyrics (in use in Harrow, &c.) 12mo. ..... 4s. 6d.
— Latin Anthology, for the Junior Classes, 12mo. ..... 2s. 6d.
Yonge's Latin Gradus, post 8vo. 9s. or with Appendix .....12s.

The French Language.

Albitès's How to Speak French, fcp. 8vo. ..... 5s. 6d.
— Instantaneous French Exercises, fcp. 2s. KEY, 2s.
Cassal's French Genders, crown 8vo. ..... 3s. 6d.
Cassal & Karcher's Graduated French Translation Book, PART I. 3s. 6d. PART II. 5s.
Key to Part I. by Professor Cassal, price 5s.
Contanseau's Practical French and English Dictionary, post 8vo. ..... 8s. 6d.
— Pocket French and English Dictionary, square 18mo. ..... 1s. 6d.

Contanseau's Premières Lectures, 12mo. ..... 2s. 6d.
— First Step in French, 12mo. .....2s. 6d. Key 3s.
— French Accidence, 12mo. ..... 2s. 6d.
— — Grammar, 12mo. .....4s. Key 3s.

Contanseau's Middle-Class French Course, fcp. 8vo.

Accidence, 8d.
Syntax, 8d.
French Conversation-Book, 8d.
First French Exercise-Book, 8d.
Second French Exercise-Book, 8d.
French Translation-Book, 8d.
Easy French Delectus, 8d.
First French Reader, 8d.
Second French Reader, 8d.
French and English Dialogues, 8d.

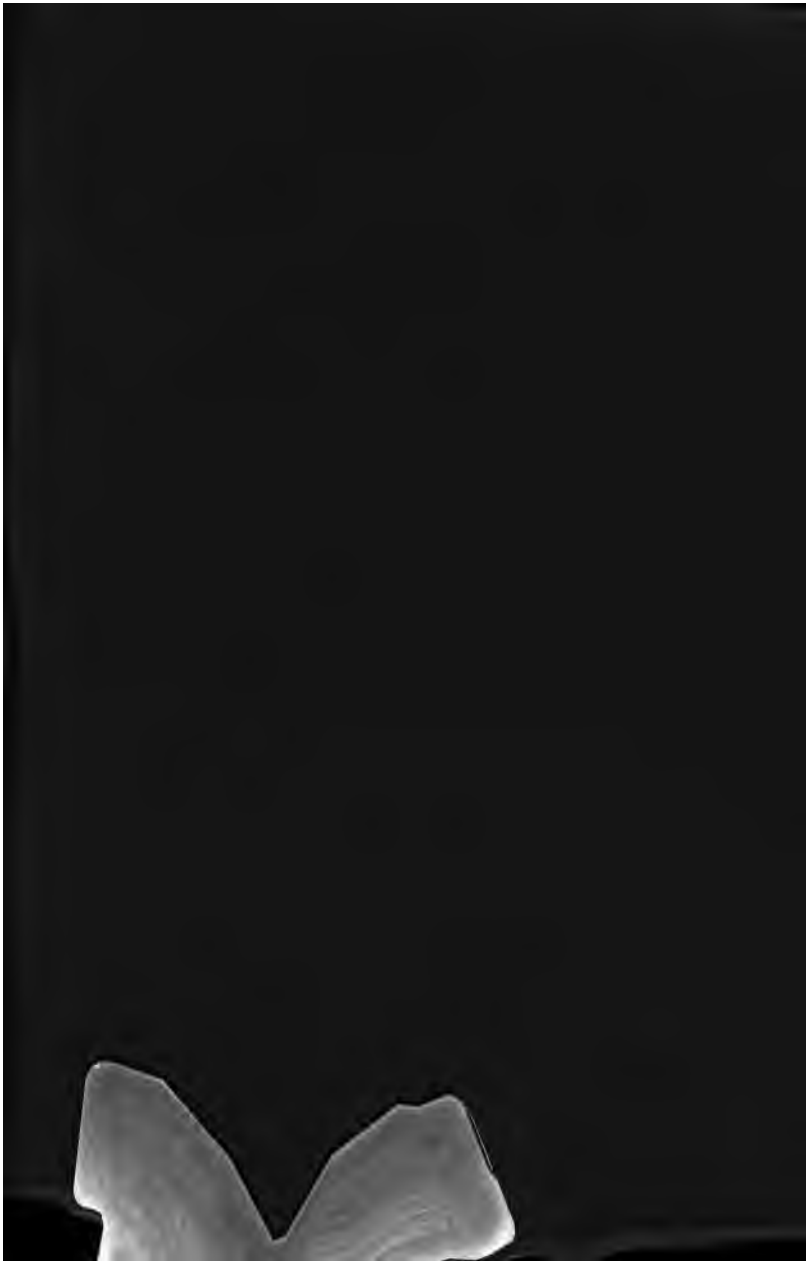
Contanseau's Guide to French Translation, 12mo. .....3s. 6d. Key 3s. 6d.
— Prosateurs et Poètes Français, 12mo. ..... 5s.
— Précis de la Littérature Française, 12mo. ..... 3s. 6d.
— Abrégé de l'Histoire de France, 12mo. ..... 3s. 6d.
Jerram's Sentences for Translation into French, crown 8vo. .....1s. Key 2s. 6d.
Merlet's French Grammar, fcp. 8vo. ..... 5s. 6d.
— French Pronunciation and Accidence, fcp. 3s. 6d. .....
— Syntax of the French Grammar, fcp. 3s. 6d. ..... } Key, price 3s. 6d.
— Le Traducteur, fcp. 8vo. ..... 5s. 6d.
— Stories from French Writers, fcp. 8vo. ..... 2s.
— Aperçu de la Littérature Française, fcp. 8vo. ..... 2s. 6d.
— Exercises in French Composition, fcp. 8vo. ..... 3s. 6d.
— French Synonymes, fcp. 8vo. ..... 2s. 6d.
— Synopsis of French Grammar, fcp. 8vo. ..... 2s. 6d.
Prendergast's Mastery Series, French, 12mo. ..... 2s. 6d.
Souvestre's Philosophe sous les Toits, by Stièvenard, square 18mo. ..... 1s. 6d.
Stepping-Stone to French Pronunciation, 18mo. ..... 1s.
Stièvenard's Lectures Françaises from Modern Authors, 12mo. ..... 4s. 6d.
— Rules and Exercises on the French Language, 12mo. ..... 3s. 6d.
Tarver's Eton French Grammar, 12mo. ..... 6s. 6d.

German, Spanish, Hebrew, Sanskrit.

Blackley's Practical German and English Dictionary, post 8vo. ..... 3s. 6d.
Buchheim's German Poetry, for Repetition, 18mo. ..... 1s. 6d.
Collis's Card of German Irregular Verbs, 8vo. ..... 2s.
Fischer-Fischart's Elementary German Grammar, fcp. 8vo. ..... 2s. 6d.
Just's German Grammar, 12mo. ..... 1s. 6d.
— German Reading Book, 12mo. ..... 3s. 6d.
Kalisch's Hebrew Grammar, 8vo. .....Part I. 12s. 6d. Key 5s. Part II. 12s. 6d.
Longman's Pocket German and English Dictionary, square 18mo. ..... 2s. 6d.
Milne's Practical Mnemonic German Grammar, crown 8vo. ..... 3s. 6d.
Müller's (Max) Sanskrit Grammar for Beginners, royal 8vo. ..... 7s. 6d.
Naftel's Elementary German Course for Public Schools, fcp. 8vo.

German Accidence, 9d.
German Syntax, 9d.
First German Exercise-Book, 9d.
Second German Exercise-Book, 9d.
German Prose Composition Book, 9d.
First German Reader, 9d.
Second German Reader, 9d.

Prendergast's Handbook to the Mastery Series, 12mo. ..... 2s. 6d.
— Mastery Series, German, 12mo. ..... 2s. 6d.
— — — Spanish, 12mo. ..... 2s. 6d.
— — — Hebrew, crown 8vo. ..... 3s. 6d.
Quick's Essentials of German, crown 8vo. ..... 3s. 6d.
Seiss's School Edition of Goethe's Faust, crown 8vo. ..... 5s.
— Outline of German Literature, crown 8vo. ..... 4s. 6d.
Wirth's German Chit-Chat, crown 8vo. ..... 2s. 6d.

Spottiswoode & Co. Printers, New-street Square, London.

6